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MINERS' LAMPS.

To place in the hands of those sturdy toilers who go down into the bowels of the earth the means of pursuing their arduous labours with a greater immunity from danger than was formally their lot is a noteworthy, nay, a triumphant achievement of science. These poor souls bury themselves during half their existence in order that humanity above ground may enjoy warmth and light: therefore is it right that those who find their work on the surface of the earth instead of beneath its crust should seek the power of equipping the underground slave with more and more improved appliances with the view of minimising the dangers which he has to encounter. Those electricians, therefore, who are endeavouring to devise a readily portable battery and incandescent lamp for use in mines deserve commendation beyond the ordinary and every reasonable encouragement.

The electric miners' lamps to whose claims to public notice we have from time to time called attention are quite numerous, and there seems to be plenty of room for workers in this direction to avoid the spectre of patent litigation. We are prepared to welcome them all, and to wish every one success in operation. But we must confess to a great deal of surprise upon perceiving the enormous sum which the vendors ask for the patents which the new Mining and General Electric Lamp Company, Limited, is formed to purchase and work. So large a sum as £80,000, at least £46,000 of which is to be paid in cash, for a few patents relating to portable batteries, or for any similar consideration, is surely unprecedented. To say that the cash payment is placed at so high a figure merely to repay the amount the vendors have actually spent and the liabilities they have incurred is introducing a new factor in the valuation of patent rights. It may be (we do not for one moment suggest that in this case it really is so) that the present vendors, when they were themselves the purchasers, made very bad bargains, or may since have spent money quite recklessly, and it is scarcely a fair thing to expect shareholders in a new concern to bear the expense of perfecting patents where that expense, added to the original purchase payment, exceeds the actual value of the patents as a commercial undertaking. Of course the proof of the pudding is in the eating, and there are at present no means of deciding with exactitude how much the value is below what is proposed to be paid; but we protest against the introduction of this element as a necessary part of the calculations in such a case. To the shareholder the value of a

patent is, not what it has cost the person from whom he purchases it, but what he can afford to pay with a reasonable prospect of making a profit when he employs it. Looked at in that light it appears to us that the sum of £80,000 is excessive. Profits will have to be paid upon a capital of £100,000, only £20,000 of which is available for working purposes. If the directors, who have amongst their number several gentlemen of great influence and repute, can demonstrate in practice that their views are right, we shall be the first to congratulate them; but, with past experience to go upon, we fear a long time must elapse before they will be in a position to receive our congratulations.

According to the prospectus, the company has been formed to acquire from the New Portable Electric Lamp and Power Syndicate Company its patents and system for the manufacture of (1) an electric miners' lamp, (2) a lamp for the electric lighting of railway carriages, (3) a lamp for domestic purposes and for use in factories and places where a portable and absolutely safe light is required. A series of experiments, extending over a period of two years, having been conducted under the superintendence of Messrs. J. and P. Higson, mining engineers, of Manchester, the directors say that they are able to announce that the miners' lamp (1) is absolutely safe; (2) with a reflector gives a light much superior to the oil lamps generally in use, and can be maintained from 10 to 12 hours; (3) weighs only a little over 5 lbs; (4) can be sold for 20s.; and (5) costs no more than 3d. per week in maintenance. If all that is claimed for this lamp, and all that is said in praise of it by those (and they are practical men of high standing) who have tried it, prove to be true, it is undoubtedly a very good lamp indeed, and we trust to see it very largely used in mines. It is not at present intended to erect factories for the construction of the lamps and batteries, but to enter into contracts with existing safety lamp manufacturers to supply the orders the company receives.

The lamp may be a success: we are not quite so sure about the company. We see, however, that it has acquired all the foreign patents of the vendors, and a considerable profit is anticipated from royalties upon or from sales outright of these. With respect to this we say that the foreign and colonial patents may, when sold, recoup the company, but that unless there be sufficiently good prospects of both the present company and the prospective sub-companies earning dividends the Mining and General Electric Lamp Company should never have come into existence, and we see with surprise such names as those of Earl Crawford, the Hon. Reginald Brougham, and Dr. E. Frankland associated with it. Arrangements for guaranteeing a subscription to the capital, the prospectus states, have been made by the vendors, and the company will take over the business of the syndicate company, and with it certain contracts. We should like to see the company, with genuine work instead of speculative sales of patents, prove successful, but for that we fear it has too heavily weighted itself at the outset.

APPARENTLY there still exist in our midst modern examples of Rip Van Winkle. Some 18 months ago Mr. Rankin Kennedy's book on "Electrical distribution by alternating currents and transformers," was published and favourably reviewed in many technical journals. The book, which dealt with a subject studied by but few and quite unknown, except by name, to the many, was much sought after, and has now been out of print for some time and, as our readers are aware, at the time of its publication the proper working of transformers was involved in great obscurity, even the Grosvenor Gallery experts being much troubled with difficulties which had to be traced to their source and then, one after the other, eliminated. It seems, therefore, somewhat late in the day to find a lengthy and ponderous review of this little work in our very excellent contemporary *Industries*, unless it is by way of a joke, for it is well-known that the much-respected London editor of our contemporary does not realise what is placed before him, whether jocular or serious, until after a considerable period has elapsed. If, on the other hand, it is intended as a commentary upon the second and enlarged edition which, however, has yet to see the light of day, the writer's remarks are a trifle premature. Considering that the development of transformers has mainly taken place since Mr. Kennedy's book was written, such remarks as "it is not a scientific exposition of the subject indicated by its title, nor is it a practical handbook which would assist the manufacturer of electrical plant in selecting the best and most approved designs . . . the book has been published to show students the position in which the practical science of the subject stands at present . . . We think students will be rather discouraged by the book, for the author makes the following remark: 'The distribution of electrical energy for electric lighting on a commercial scale is a problem which has not yet been practically solved.' It is needless to comment upon such a broad and sweeping statement; but the effect on a student approaching the question without any other knowledge than that obtained from personal observation of electric lighting as actually carried out, must, to say the least of it, be very bewildering," can only be considered as utterly out of place and entirely misleading. Of course many designs for transformers have been brought forward since the publication of Mr. Kennedy's book; the subject necessarily stands now in a different position to that of 18 months ago; and, our contemporary notwithstanding, we do not think many people will be found bold enough to say that the problem quoted *had* been practically solved at the date spoken of. If students, or editors, choose to emulate the example of Washington Irving's creation, even for so short a period as a year and a half, they will naturally find in these progressive days that things have changed.

OUR contemporary, the *Electrician*, criticises certain statements which we ventured to make in a leading article of our issue of November 16th. This criticism, we may almost call it censure, coming as it does from

so influential a quarter, cannot be left unanswered, much as we regret this unpleasant duty. We say unpleasant, advisedly, because we are reluctantly forced to point out the general state of misconception which the writer of leaderettes in the *Electrician* reveals on the subject of electric traction by means of storage batteries. Our esteemed contemporary is under the impression that this problem will only receive its solution when an *ideal* cell is found. No definition is given as to what such an ideal cell is to be or to do, except "that such a cell will depreciate at one n th the present rate, and will have n times the capacity with one n th the weight per horse-power—the value of n being certainly not less than three or four." If it had been stated numerically what the "present rate" of depreciation is, and, at the same time, such types of cells mentioned as were uppermost in the mind of the writer at the instant when these remarkable words were evolved, then there would have been some sense in his statement. If we are to wait for an ideal cell, or the minimum value of n , whatever that may be, then the question of electric traction with storage batteries will have to be shelved until the coming of the millenium, and if this policy is extended to other inventions, which never reach the *ideal*, then there is an end to all industrial progress; in fact, we should cease to exist. We are not inclined to such pessimistic views; on the contrary, we have always encouraged *bona fide* workers to further efforts, and we have had the satisfaction of watching very considerable progress just in the very direction which our contemporary so decries, and which its respected editor has so long neglected, or given up as "love's labour lost." What we want to-day is not an "ideal cell," but a storage battery which will perform the work of horses (in the case of tramcars) in a satisfactory manner, and do this economically and efficiently. That a tramcar *can* be moved by storage batteries and motors was demonstrated years ago. We also know the amount of energy necessary to move a loaded car over a certain road at a given speed; thus we find the cost of *power* per annum or per car mile. We have also seen that the weight of the battery does not exceed one-quarter of the total load to be propelled, and that there is ample space for the cells under the seats. What we did not know precisely until a comparatively recent date was the depreciation of the cells; but we are informed by Mr. Reckenzaun that he has for some time past agreed with his customers to maintain his storage batteries for tramcars for one penny per mile run by each car, and in the alternative he offers to show his customers how to maintain the same themselves for a much smaller amount. This, we believe, solves the question completely.

FURTHERMORE our esteemed contemporary indulges in the baneful and mischievous practice of contradicting itself. It gravely says:—"We believe, nevertheless, that storage cells have not yet been permitted to show what they really are capable of doing for electric traction. We refer to the fact that in every case that has come under our notice, arrangements have been provided for coupling the cells in one or more sets in parallel so as to obtain a convenient E.M.F. for starting the motors and for variations of speed. In theory this

is, of course, a highly tempting arrangement, particularly as it involves no immediate waste of energy; but in practice we regard it as most pernicious, and we are at a loss to account for the fact that those who are interested in the success of accumulators have so long tolerated it without protest. It is simply impossible that any set of cells should all have indentially the same E.M.F., and wherever the slightest inequality exists the cells, if coupled in parallel, are placed in a condition of unstable equilibrium." Now this doctrine was preached years ago by Mr. Reckenzaun, and almost the same words have been used by him at various times. The *Electrician* published it, and said nice things of him in its issues of December 20th, 1884, and again on April 4th, 1885, for an ingenious device which he had invented in order to overcome this serious drawback. Mr. Reckenzaun saw the necessity of a constant E.M.F., as also the desirability of doing away with artificial resistances for varying speed or power whether used with storage batteries or with conductors, and he says in his patent specification: "I propose to overcome to a great extent the difficulties above indicated, by employing two or, if desirable, more than two, electro-motors, which, when working together, will give the requisite power for starting and for mounting inclines. These several motors may be alike in size, or they may be different; but the number of their revolutions is made to correspond, and the gearing employed for the transmission of their motion is arranged accordingly. I so arrange the circuits that by means of a switch or commutator, the motors may run in series, in parallel, or singly, or partly in series and partly in parallel. I may also arrange the field magnet circuits distinct from the armature circuits, and join their terminals in a variety of ways known as in series or in parallel, and thereby vary the resistances without inserting any idle or artificial resistance. The coils of the field magnets may also be wound in either of the manners technically termed "shunt wound" and "compound wound" respectively; and either the whole or part only of this winding may be separately excited by means of the battery or other source of electricity; and such separate exciting current may be made to flow in large or small quantities as desired, by either varying the source of current, or by varying the resistance of the coils above referred to. As the amount of current flowing through an electromotor when the same is at rest depends upon the resistance of its armature and field magnets, it is necessary, in order to prevent an excessive current being used when starting a vehicle, that the circuit of the several motors should be arranged so as to give a high resistance with a consequent comparative low speed. After starting, and as soon as a greater speed is desirable, the armatures of the several motors, or the field magnet coils, or both the armatures and the field magnet coils may be joined by a switch arrangement in parallel, or partly in parallel or partly in series. The speed as well the power of the motors can be varied in this manner, for as the resistance of the whole circuit changes, so also changes the speed of the armatures when the electromotive force of the supply current is constant." This idea originated with Mr. Reckenzaun, but it appears that Mr. F. Sprague has recently adopted a precisely similar mode, as shown in his reply to Mr. A. T. Snell's letter in our issue of last week. This disposes effectually of that part of the *Electrician's* leaderette which refers to suggestions of means for varying the speed of cars driven by accumulators.

AT the invitation of Sir Edmund Hay Currie, Chairman of Trustees, a very large number of visitors had the pleasure on Saturday last of inspecting the splendid new technical schools recently built in connection with the People's Palace, Mile End Road, by the Drapers Company. A large proportion of the company, probably for the first time, became aware of the meaning of the term "technical education," and were allowed full liberty to wander over the vast institution, including the Queen's Hall, in which a concert was given, and the gymnasium, in which there were displays of skill by the members. All the different departments of the schools were open for inspection, and the boys of the technical day school were seen at work at the forge, the bench, the vice, the lathe, and many other things, forming, in the whole, one of the most busy and interesting communities ever seen. Boys were also working at experiments in the chemical laboratory, which is fitted up in the most perfect manner and supplied with steam, water and gas. In the elementary laboratory instruction is given in qualitative analysis specially directed to meet the requirements of the Elementary and Advanced Examinations held under the direction of the Science Department, South Kensington; and there is also an advanced laboratory specially fitted to afford instruction in ordinary commercial analysis, such as determining the strength of soda ash, analysis of water, and generally the analysis of substances used in chemical manufactures, the desire of the trustees being to render this department of their work a special centre for the furtherance, in every possible way of the chemical industries of East London. A visit to the Art School was equally interesting, the degree of excellence in the work upon which the boys were engaged being quite astonishing, while at wood carving, modelling and kindred arts, there was also a degree of cleverness evinced far in advance of what could be expected from such juvenile craftsmen. From the prospectus we learn that the fees payable by the scholars in this excellent technical day school for boys is only 6d. per week or 5s. per quarter, which entitles to instruction in mathematics, machine construction and drawing, mechanics, magnetism and electricity, practical, plane and solid geometry, chemistry, free hand and model drawing, modelling; and, as required, special instruction is added in photography, carpentry and joinery, metal turning and lathe work, tailors' cutting, upholstery cutting, cabinet making and other things. There are also evening classes in the subjects named above, the fees varying from 1s. per quarter upwards.

THE death of M. Lucien Gaulard, under peculiarly saddening circumstances, must fill the minds of all who were acquainted with the man or with his work with intense regret. M. Cadiot, to whom we are indebted for intelligence of the sad event, pictures the deceased inventor as the victim of science and his own genius, and there may be much of truth in this description. At all events there can be but little doubt that the cares and disappointments incurred in connection with the contests over his patents must have seriously aggravated anterior tendencies, and the final breakdown was doubtless greatly hastened in this way. Whatever opinions may be held with regard to the legal position of M. Gaulard's patents, all must admit the large share which he has taken in making the employment of secondary generators practicable and popular.

EXCLUSIVE CONCESSIONS.

DON ANTONIO BALBIN DE UNQUERA contributes two articles to the *Voz de la Patria*, of Madrid, on the subject of exclusive concessions and privileges. The question as to the rights acquired by the possession of concessions of this nature is a matter of importance to more than one English telegraph company, and to these the views held in certain quarters upon the subject may be of interest. We therefore give a translation of the articles above referred to:—

"We are about to deal with a question which, always of importance, demands to-day considerable attention from our Government, and more particularly from our Ministers of Marine. Since Mr. Cyrus Field laid the first telegraph cable between Ireland and Newfoundland, and Queen Victoria and President Buchanan exchanged congratulations across the ocean upon the addition to the means of communication between their respective countries—an addition due to the wonderful and incessant progress of science—that event created the desire of imitation, and all European Governments found themselves besieged by an army of speculators who, with capital and often without it, solicited fresh telegraph concessions. Naturally, Spain was one of the countries most fancied for this sort of demand, and our Administration, if not very active, at all events exceedingly generous, considered it advisable to listen to a good many petitions of this nature.

"Two companies, called the 'International Ocean' and the 'West India and Panama,' obtained concessions, and for no less a term than 40 years, for communications with America.

"These exclusive concessions have brought about, as a necessary consequence—1, obstructions of all sorts, and such as are with difficulty to be overcome, in the way of fresh concessions; 2, an injury to the general public, which is prevented from benefiting as a result of competition (were other companies admitted to a share in the concessions) by a reduction of tariffs.

"The results of the exclusive concessions were not long in making themselves apparent; the before-mentioned companies laid their cables and commenced working, but they neglected to extend their lines to many necessary points; other companies then desired to complete the work left undone, and this struggle between conflicting claims placed the Spanish Government in an awkward position, which will last so long as the exclusive privileges hold good.

"It is evident that the Government could not set aside its obligations; but it is not the nature of foreign companies to remain with folded hands while they see a monopoly legally established and the privileged ones threatening to demand heavy damages should their concessions be modified or their privileges diminished in any way. Meanwhile private persons are paying more than they should, and the country in general remains without certain lines, every day more necessary for improving its means of intercourse with the new world. The laying of lines parallel to those now owned by the before mentioned companies is forbidden, but this idea of 'parallel lines' is not the geometrical conception; the Administrative meaning of 'parallel lines' is this: those lines which, starting from the same point, traverse approximately the same ground; but we may ask what point is meant? Certainly not the mathematical, which has neither length nor breadth, nor the physical, which, if it contains these qualities, can be accurately localised in any determined spot. The point contemplated consists of the whole Spanish coast, which, as our readers know, is fairly extensive.

"The truth is that it has become necessary to define in some other manner, the prohibition, if indeed it must be continued, and to alter the privileges mentioned in such a way that a monopoly will be impossible, and the service, now carried on entirely by exclusive concessionaires, be cheapened. We do not say how this is to be done; but the Government should consider the matter in view of its importance to society in general, to commerce in particular, and with regard to our intercourse with America.

"We have already shown the possibility of there arising conflicts, to which we can foresee no limit, between the privileges of the International Ocean and West India and Panama Companies on the one hand, and those enterprises which demand concessions for cables to those places on the Continent and islands of America as yet unconnected with our Peninsula.

"We might raise the question as to whether the holders of the concessions have really laid all the cables specified in their contracts, and in case they have not done so, we might raise the question as to the concessions becoming null and void; but this is not our purpose; we might enquire if their lines which ought to be national, have become international, by touching at territories other than Spanish; but we do not intend to take up this argument since we can understand that very possibly there may have existed weighty reasons at the time the concessions were granted, for conceding exclusive privileges for 40 years, a piece of generosity the English would certainly not have exhibited.

"Our intention is to meddle with no one in his enjoyment of what he legally possesses; we only desire to reconcile with this possession those public and private interests which demand immediate attention, and to bring about that competition which, while cheapening the service, must at the same time improve it, and we believe that a remedy for the evils complained of will be found in the suggestion we are about to make, presuming that the International Ocean and West India and Panama Companies recognise, as we do, that the work they have carried out does not offer so many difficulties, as, for instance, the construction of railways, and that it is not right that they should continue to present a perpetual obstacle to the extension and cheapening of telegraph communications.

"We consider that the two companies mentioned, each with regard to the particular privileges it enjoys, can and should reconcile their interests with those of the other concessionaires, receiving from the latter a portion of their profits, gradually reduced in amount according as the conclusion of the exclusive concessions is approached, and such arrangements should be entered into by contracts and agreements approved of by the Government. By this means there would be no occasion for declaring the contracts null and void, nor would the Government be obliged to indemnify the two companies mentioned; these would continue to reap the benefit of their privileges so far as they were justly entitled, and those countries not as yet telegraphically united with our own, would be relieved from the disadvantages which they now labour under."

ON THE MAGNETISATION OF IRON AND
OTHER MAGNETIC METALS IN VERY
STRONG FIELDS.*

By J. A. EWING, B.Sc., F.R.S., Professor of Engineering in University College, Dundee, and WILLIAM LOW.

[ABSTRACT.]

EARLY in 1887 the authors communicated to the Royal Society the results of experiments made by subjecting iron to strong magnetic force by placing the sample, in the form of a bobbin with a short narrow neck and conical ends, between the pole-pieces of an electro-magnet. The experiments have been continued and extended by using much stronger magnetic forces and by testing samples of nickel, cobalt, and various steels, as well as wrought iron and cast iron. The large magnet of the Edinburgh University Laboratory, kindly lent by Prof. Tait, was used throughout the experiments, and allowed the authors to effect a high concentration of the magnetic force by using bobbins, the necks of which had a cross-sectional area of (in some cases) only $\frac{1}{16}$ of the cross-sectional area of the magnet cores. By this means the induction, $\mathfrak{B}$, was raised to the following extreme values:

* Read before the Royal Society, November 22nd.

In wrought iron	...	...	45,850 c.g.s.
" cast iron	...	...	31,760 "
" Bessemer steel	...	...	39,880 "
" Vickers's tool steel	...	...	35,830 "
" Hadfield's manganese steel	...	...	14,780 "
" nickel	...	...	21,070 "
" cobalt	...	...	30,210 "

The induction was measured by means of a coil consisting of a single layer of very fine wire wound upon the central neck of the bobbin. Outside of this coil, at a definite distance from it, a second coil was wound, and the magnetic force was determined in the annular space between the two. In a paper communicated to the Manchester meeting of the British Association, the authors showed that if the force so measured could be proved to have the same value as the magnetic force within the metal neck itself, it would follow that the intensity of magnetism, $\mathfrak{J}$, had begun to diminish under the action of excessively strong fields, in the manner which Maxwell's extension of the Weber-Ampère theory of molecular magnets anticipates. In the present paper the authors discuss at some length the question of how far the magnetic force within the metal is fairly measurable by the magnetic force in the ring of surrounding air, and they show that with the form of cones originally used the force within the metal must have been less than the force outside, by an amount probably sufficient to explain the apparent decrease of $\mathfrak{J}$. The form of cone suited to give a uniform field of force with sensibly the same value in the metal neck and round it is investigated; and experiments are described in which the condition necessary for a uniform field was satisfied. The results of these experiments are conclusive in showing that no considerable change takes place in the value of $\mathfrak{J}$ (in wrought iron) when the magnetic force is varied from about 2,000 to 20,000 c.g.s. units. Throughout this range of force, the intensity of magnetism has a sensibly constant value of about 1,700 c.g.s. units, which is to be accepted as the saturation value for wrought iron. The term saturation may be properly applied in speaking of the intensity of magnetism, but there appears to be no limit to the degree to which the magnetic induction may be raised.

To produce the greatest concentration of force upon the central neck the converging pole faces should have the form of cones, with a common vertex in the middle of the neck, and with a semi-vertical angle of $54^\circ 44'$. This form, however, does not give a uniform field in the neighbourhood of the vertex. To secure that the condition is that d^2F/dx^2 , d^2F/dy^2 , and d^2F/dz^2 shall vanish, F being the magnetic force at the vertex, which is due mainly to the free magnetism distributed over the pole faces. The condition for a uniform field is satisfied when the cones have a semi-vertical angle of $39^\circ 14'$. When this form is given to the cones, the magnetic force in the air immediately surrounding the central neck may be taken as sensibly equal to the force within the neck, and it therefore becomes practicable to measure the relation of the induction to the force producing it—that is to say, the magnetic permeability.

The greatest attainable concentration may be calculated by assuming the pole faces to be saturated, when the cones are such as to have maximum concentrative power (semi-vertical angle = $54^\circ 44'$). Under these circumstances the magnetic force at the vertex due to the free magnetism on the conical faces is—

$$18,930 \log_{10} \frac{b}{a},$$

where b is the diameter of the poles at the base of the cones, and a the diameter of the central neck.

The following are probable values of the intensity of magnetism when saturation is reached in the particular metals examined:—

	Saturation value of $\mathfrak{J}$.
Wrought iron	1,700
Cast iron	1,240
Nickel (with 0.75 per cent. of iron)	515
Nickel (with 0.56 per cent. of iron)	400
Cobalt (with 1.66 per cent. of iron)	1,300

Experiments were also made with specimens of Vickers's tool steel and other crucible steels, Whitworth's fluid-compressed steel, Bessemer steel, Siemens steel, and Hadfield's manganese steel. This last material, which is noted for its extraordinary impermeability to magnetic induction, was found to have a constant permeability of about 1.4 throughout the range of forces applied to it—namely, from 2,000 to nearly 10,000 c.g.s.

The results are exhibited graphically by curves drawn in Rowland's manner, to show the relation of the permeability to the magnetic induction. In the highest field examined the permeability of wrought iron had fallen to about 2.

MINIMISING THE BANEFUL EFFECTS OF THE EXTRA CURRENT.

By M. VASCHY.

THE injurious effects of the extra current of rupture in a circuit of considerable self-induction are of two kinds. The sparks which burst at the point of rupture (primary circuit of Ruhmkorff's coil, brushes of dynamos, telegraphic apparatus, &c.), oxidise the contacts, increase the resistance, and reduce the useful effect of the current. From a physiological point of view, the danger of the extra current is still more serious, and may become deadly.

Various means have been proposed to lessen these effects: (1), a condenser employed in the manner of Fizeau (Ruhmkorff's coil); (2), condenser in derivation between the extremities of the electro-magnet (relays and telegraphic apparatus); (3), rheostat in derivation on a dynamo (D'Arsonval, *Comptes Rendus*, January and March, 1885); (5), telegraphic lightning rod in derivation (Raynaud, *Comptes Rendus*, March, 1885), &c.

I purpose to show how the conditions of efficiency of these means may be submitted to calculation and expressed in figures. To this end we shall admit that for the suppression of these injurious effects the difference of potential at the extremities of the electro-magnet should not at any moment exceed a maximum E , the value of which has to be fixed (100 volts, 200 or 500 volts, as the case may be).

1. *Rheostat in derivation on the electro-magnet.*—Let R be the resistance of the electro-magnet, I the normal intensity of the current traversing it, ρ the resistance of the rheostat, the self-induction of which may be overlooked. On the rupture of the exterior circuit the electro-magnet and its shunt form a closed circuit, in which the current sinks gradually from I to zero. The maximum difference, V , of potential at the extremities of the shunt, and consequently at those of the electro-magnet, cannot exceed ρI . It results that the efficiency

of the shunt will be secured if we take ρ less than $\frac{E}{I}$.

Example.—Morse electro-magnet ($R = 500^\circ$, $i = 1.015$ a = normal working current). If we wish that V should not exceed $E = 150$, we only need give the shunt a resistance ρ less than $10,000^\circ$.

If we take account of the very slight self-induction of the shunt, the result is not sensibly affected. The calculation would be too long to be developed here.

Voltameters in derivation.—We take voltameters of such a number that their maximum electromotive force, e , may slightly exceed the normal difference of potential, $R I$, at the extremities of the electro-magnet. Let R be their resistance.

On repeating the above reasoning, we find that the maximum difference of potential, V , at the extremities of the electro-magnet during the rupture cannot exceed $\rho I + e$, or approximately $(\rho + R) I$. If the resistance, ρ , of the voltmeters is small, V will scarcely exceed the difference of potential, $R I$, of the normal condition.

By reason of their considerable capacity of voltaic

polarisation, the use of voltmeters is suitable only in case of currents essentially variable (telegraphic transmissions, alternating dynamos, &c.)

3. *Condenser in derivation on the electro-magnet.*—Let R and L be the resistance and the self-induction of the electro-magnet, I the normal current, C the capacity of the condenser. On the rupture of the exterior circuit, the electro-magnet and the condenser form a closed circuit, in which the current, i , declines gradually from I to zero. This current, i , causes the charge, Cv , of the condenser to decrease, and consequently the difference, v , of the potential at the extremities. When the discharge is complete, if the intensity, i , is reduced to zero, the extra current comes to an end without v having exceeded the normal difference of potential, RI , the condition of efficiency is, of course, fulfilled. This case occurs when C exceeds the value of $\frac{L}{4R^2}$ as a calculation in full would show.

But it may happen that when the charge of the condenser becomes null, the current has still an intensity, $i < I$. The charge, Cv , continues then to decrease. v equally changes its direction, and reaches a maximum, when the current, i , becomes null. Then the condenser discharges itself anew, and thus in succession. This is the phenomenon well known as the oscillating discharge. The point is to keep v below the fixed maximum, E .

At the moment when the condenser is entirely discharged, the current having the intensity, i , the energy still to be expended is $\frac{1}{2} Li^2 < \frac{1}{2} LI^2$.

Then, since the intensity, i , has fallen to zero, the energy still available is $\frac{1}{2} Cv^2 < \frac{1}{2} LI^2$. Then, in order that v may be smaller than E , we must have

$$\frac{1}{2} LI^2 < \frac{1}{2} CE^2 \text{ or } C > \frac{LI^2}{E^2}.$$

This is a sufficient condition of efficiency; the necessary condition is obtained by a calculation too complicated for practice. We shall therefore adopt as the lower limit of the capacity C , the value $\frac{LI^2}{E^2}$ or the value

$\frac{L}{4R^2}$ if this is lower than the former.

Example.—Electro-magnet Morse ($L = 10$, $i = 0.015$ a), if we fix $E = 150$ volt we must take C greater than 10^{-7} farad or $\frac{1}{10}$ microfarad.

4. *Case of an intentional rupture of the circuit.*—We may break a circuit by introducing resistances increasing progressively up to infinity. The duration of such a rupture must not be less than $\frac{LI}{E}$ if we wish

the electromotive force of self-induction not to exceed the fixed maximum E . The law according to which it is advantageous to introduce the progressive resistances is easily calculated.

The other means which have been proposed or which might be studied with a view to reduce the bad effects of the extra current may be calculated in an analogous manner.—*Comptes Rendus.*

NEW METHOD FOR IMPROVING THE WORKING OF TELEGRAPHIC LINES AT GREAT DISTANCES.

By M. FERNAND GODFREY.

THIS method consists in establishing at each extremity of the line at the entrance to the telegraphic station an earth shunt having a coefficient of self-induction so considerable that the well-known injurious effects resulting from the electrostatic capacity of the conductor, during the variable period of the current may be, if not compensated, at least greatly reduced by the inverse effects due to self-induction.

It is applicable to different systems of transmission,

which may be divided into three classes:—1, those in which all the emissions, whatever their character, positive or negative, should produce a signal and are separated by intervals during which the line ceases to be in communication with an electric source; 2, those in which the line is always in communication at the transmitting station with a battery sometimes positive and sometimes negative, the positive currents being used as working currents or printing currents, and the negative currents as currents for cessation or for spacing; 3, those which partake at once of the two former—as, for instance, certain transmitting apparatus with discharge currents.

In the first case the shunt affords at the beginning of the emission, and in virtue of its electro-magnetic inertia, an apparent considerable resistance, and it does not sensibly weaken the current which charges the line. It gives rise then at the end of the emission to an extra current, which acts to facilitate the discharge of the line, as an emission would do of a contrary direction succeeding without interruption to the former. The signals at the reception station are thus more distinctly spaced, and the recipient at the forwarding station is protected against the effects of the discharge current or return current.

In the second case the shunt likewise gives rise at the moment of each inversion to an extra current, acting immediately and producing the same effect as if the inverse battery had been momentarily augmented. It contributes, therefore, to diminish the duration of the variable period, and consequently to increase the speed of transmission.

In the third case its action is explained in the same manner as in the two others.

The above considerations concern the action of the shunt placed at the transmitting station. Now the complete system allows of a similar shunt at each end of the line. But it has long been known that an electro-magnetic shunt at the receiving station favours the rapidity of the transmissions and the distinctness of the signals. This is an effect which has long been known and utilised, especially on the long aerial lines in India.

The presence of a shunt of the same nature, about the middle of the line, produces an analogous effect, as I have found experimentally, but it involves the employment at the extremities of the line of more sensitive recipient apparatus or of rather stronger batteries.

The method being applicable, as it has been said, to the generality of telegraphic systems, whatever may be the apparatus at the terminal or intermediate stations (transmitters, relays, recipients, &c.), affords a means of substituting a simpler arrangement for the so-called processes of discharge, or of mechanical compensation or others which are now in use, especially in submarine and in some submarine lines.

It has been successfully tried at the central telegraphic station, with the sanction of the Administration, upon several underground lines at great distances, among others on that from Paris to Angoulême (500 kilometres). In the course of experiments with this last locality it has been found practicable to transmit at the rate of 20 words per minute with an ordinary Morse apparatus, without relays, intermediate or local, and utilising only one direction of the current. The line had a resistance of 5,000 ohms and a capacity of 100 microfarads; the shunt, which comprised an electro-magnet with a closed magnetic circuit and a small auxiliary coil, had a resistance of 780 ohms and a coefficient of self-induction equal to 12 practical units; the battery was formed of 50 Callaud elements.

Results equally satisfactory have been obtained with other apparatus, but the example given may suffice.

Experiments have proved that it is not practically indispensable to have a perfect neutralisation of the inverse effects of the capacity of the line and of the self-induction of the derivation. The same electro-magnet has given equally good results on underground lines of from 250—350 kilometres; another has served for trials upon lines of 400 to 700 kilometres. It is

sufficient for each fresh line to take the battery suitable for that line and then to vary a little the resistance of the auxiliary bobbin, or to break the magnetic circuit of the electro-magnet and remove some of the pieces of soft iron forming the keepers.

We may always for more delicate experiments have recourse to boxes containing a certain number of bobbins or of electro-magnets, arranged so that they may be grouped at pleasure.—*Comptes Rendus*.

ELECTRIC HAULAGE IN THE ANTHRACITE MINES.*

By A. W. SHEAFER.

THE introduction of electricity as a motor for underground haulage in the anthracite mines of Pennsylvania is a matter of great interest to mining engineers, since its success or failure will have much to do with its application to the various operations now consuming steam, such as pumping, drilling, and hoisting.

The common method of hauling the coal to the main outlets is still by mule power, replaced in some instances, however, by mine locomotives, and in one case only, to the writer's knowledge, in the Schuylkill region, by the endless rope system.

Mine locomotives are, however, very objectionable, and even in some of the recent leases prohibited, on account of the danger to good ventilation caused by the noxious gases thrown off during the combustion of their fuel. In consequence of this they can only be used in the gangways carrying the return current. The electric locomotive avoids this, as well as other objections, since the generator is entirely outside of the mine. It is only limited in its use by the extent of the tracks supplied with the conductor rail or wire.

The Lykens Valley Coal Company at their mines in Dauphin County have introduced the electric locomotive with, it seems, considerable success. The road here is 6,300 feet long, supplied with a third rail carried along the side of the gangway. The average load is 20 cars per trip, or 850 tons per day, equivalent to 1,040 mile-tons per day. The Union Electric Company, who furnished this plant, give the daily expenses of running the locomotive as \$5.71, or a cost per mile-ton of $1\frac{1}{10}\%$ cents. This, they claim, can be reduced by the use of better graded roads and heavier mine waggons to $1\frac{1}{10}\%$ cents per mile ton. The writer, in Vol. V., No. 2, August, 1882, p. 150, gave the relative costs of mule and steam locomotive haulage at Kalmia Colliery, and now introduces them here for comparison with electricity as follows:—

	Mule.	Steam.	Electricity.
Cost per ton-mile,	$1\frac{1}{10}\%$ cents.	$\frac{1}{10}\%$ cents.	$\frac{1}{10}\%$ to $\frac{1}{10}\%$ cents.

It should be borne in mind that the costs as regards mule and steam power are based upon the prices of 1882, while the estimate for electricity is for 1887, consequently the comparison is not entirely a just one, but it is made to show that we may expect, under favourable circumstances, electric haulage to at least do the work required as cheaply as steam-power and with less attendant danger to the mine.

Proposal to Buy Up a Gas Company.—In accordance with a resolution passed not long since at a public meeting, steps are being taken by the Bournemouth Commissioners with the view of acquiring for the town the works and interests of the local gas company. The directors of the latter are to be waited upon shortly and invited to mention a price. In the meantime the lighting committee have been asking for a further diminution in the charges for the public lamps.

* From the proceedings of the Engineers' Club, of Philadelphia; read June 2nd, 1888.

REVIEWS.

Die Accumulatoren für Elektricität. By Dr. E. HOPPE.
Berlin: Julius Springer.

To ordinary observers, who are accustomed to measure progress by the interval between experiment and application, the thought must have occurred at times that the storage battery was doomed to an unfortunate existence. Unlike many other discoveries, the theory of polarisation was clearly established and understood long before the practical development of the secondary battery from an experimental apparatus into an article of commerce. Improvements came gradually and slowly. Years of labour were spent in collecting data regarding the peculiarities of the materials of which the batteries were composed, and much ingenuity had to be exercised in arranging, separating and studying a great variety of phenomena. Experience, time, and close application were requisite for the discernment of small causes which often created great but undesirable effects. Even when a type has been formed on the basis of acquired knowledge, there remains always something to add, to alter, or to reject, and this process is still going on more or less—more in new ventures, less in older established processes.

In these pursuits, the first investigators who tried to bring secondary batteries to a commercial success laboured under very great disadvantages. Most of them failed, yet they are entitled to praise.

The storage battery industry has meanwhile developed into an art, which cannot be learnt from books, no matter how resolutely a man may apply himself to its study; it has to be learnt in the workshop just as every other art. It is a new art, understood by few, though professed by many, because of its apparent simplicity.

The book before us does not profess to teach the art of manufacturing serviceable accumulators; this was not the intention of the author. Dr. Hoppe promises no more in his preface than he is able to keep faith with in the subsequent pages, and he plays his part with remarkable ability. Some of our readers may be acquainted with his "Geschichte der Elektricität." The present volume might justly be called the history of the storage battery, since it recounts most of what is known from the time of Humboldt to the present day. Being an historian as well as a physicist, Dr. Hoppe is well qualified for the task he has undertaken. He displays great industry in the collection of material, and in giving accurate quotations of the sources from whence he derives his knowledge. We may observe, however, that many of the sources are secondhand, as found in translations. Dr. Hoppe's knowledge of this branch of electrical science has, moreover, been mainly acquired by reading; but this fact ought not to detract from the value of the information contained in the book, sound judgment having been exercised in discriminating between opinions and facts, between advertisements of speculators and *bond fide* attempts of earnest workers. Though he commits slight errors, we must give the author credit for having done his best, and the language and style reveal throughout unmistakable evidences of honest intentions.

As a book of reference it leaves little to be desired, and it will be a welcome addition to the library of the expert as well as of the student of this branch of science. The work is arranged in four great divisions, each of which is again subdivided into several parts. Thus:—I. *The physical principle of the accumulator.* A. Electrolysis and production of currents in a cell. This gives an account of the original discovery of the chemical effects of the electric current, made by Dr. Ash, of Oxford, who writes a letter to A. von Humboldt on the 10th of April, 1796, wherein he relates the following discoveries:—"If you lay two zinc plates, moistened with water, one over the other so that they touch in many points, you will observe very little effect. But if you use one plate of zinc and the other

of silver a very marked effect will be created. The zinc appears to become oxydised, and the whole surface of the moist silver plate is covered with a fine white powder. Lead and mercury affect one another, so also iron and copper." Humboldt repeated these observations, and he was the first to notice a decomposition of water, proving, at the same time, that oxygen moved towards zinc, and that the rising bubbles contained hydrogen. This occurred before the invention of Volta's pile, which created so much attention throughout the world, after the celebrated meeting of the Paris Academy on the 7th November, 1801.

Ritter's investigations in the year 1799 were more exact and far reaching. He knew of Humboldt's experiments, and repeated them with similar success, improving upon them in the following manner: He laid upon a moist plate of glass two blocks of bright but different metals, keeping them a short distance apart. When circuit was made by touching both metals with a piece of wire, oxidation was manifested immediately under ordinary temperatures. When heated to 80° Reaumur decomposition took place very rapidly; in fact, in as many minutes as under normal temperature it took hours. Then follow the experiments and observations of Nicholson and Carlisle, Davy, Erman, Porret and Daniell, the theories of Grotthaus, Ampère, Fechner, de la Rive, Becquerel, and many others. Faraday's experiments and definitions receive, of course, due attention, and this section teems with interesting quotations.

B. Secondary phenomena, which are connected with the development of a counter E.M.F. The author draws here a distinction between two kinds of polarisation which can possibly occur: either the ions attach themselves to the electrodes and cover them with a film of electrically-opposing properties, or the ions combine with the electrodes and alter thereby the position which they originally occupied in the scale of E.M.Fs. The first kind can only occur in the separation of gaseous or solid coatings, both of which possess a certain degree of constancy, and which generate a current of opposite direction to that which originally produced the said coatings. The first observations on polarisation were made by Ritter; he invented the secondary battery, but his theoretical explanations of the charging process were not happy. Volta put the subject into a clearer light, and demonstrated the existence of gas polarisation. Then followed the researches of Lenz and Saweljew, which resulted in the establishment of certain laws known as Lenz's laws.

Sub-section C. treats of the polarisation caused by a change in the electrodes, notably, in the formation of peroxides. Up to the year 1860 the great majority of experimenters confined themselves to researches on the polarisation of gases, and the more important investigations relating to changes in the materials of which electrodes were made received comparatively little attention. Sinstedden investigated the effects of continuous currents of a magneto-electric machine upon several voltmeters, joined in series, and found that the platinum electrodes in diluted sulphuric acid were attacked, not by oxidation, however, but small particles of the metal detached themselves and dropped to the bottom of the glass vessel. Silver plates were used with remarkable effects, and finally lead plates in sulphuric acid diluted with water were subjected to a series of tests, with the now well-known results. According to records Sinstedden used two lead plates 7 inches in length and 4 inches wide. The current from the magneto-electric machine caused in the first instance both plates to be covered with gases, next the positive plate became covered with a brown film of peroxide of lead on the entire surface opposed to the negative plate, and slightly brown near the edges of the outer surface. The negative plate assumed a dark gray colour without any deposit which was observed with silver in another experiment. During the discharge both plates retained their colours. Similar phenomena were observed with nickel plates, whilst zinc plates were soon rendered useless through large quantities of white deposit.

By adding alkaline solutions to the sulphuric acid

polarisation could be prevented; in this case ozone is formed in quantities which prevents polarisation. Gmelin has also directed attention to the fact that peroxides of lead or manganese produce a decided electro-negative effect. Dr. Hoppe sees in the foregoing observations of Gmelin and Sinstedden the complete theoretical principles of accumulators established, but no one followed the subject up practically until Planté resumed it with an energy and perseverance which made him so famous all the world over.

II. *Construction of Accumulators.*—Here the reader is made acquainted with Planté's work; how he was induced by a proposition of Jacobi to utilise secondary currents for telegraphic purposes. The most important experiments, methods of "forming" plates, and the views of this scientist are given in a condensed form. These renewed endeavours of Planté, says Dr. Hoppe, brought the accumulator question under the immediate cognisance of the electrical world, for, although the results of his forerunners were strikingly great, they could not be regarded as offering a solution to the problem. Through the publication of his researches Planté created a general interest in the subject, and he prepared the foundation to the inventions of Faure and all the succeeding workers in the field, who had the direct benefit of his studies. Faure's improvements are described, and after stating the claims contained in the patent specification the author exclaims, in astonishment, "What can mortals not get patents for!" Thereby he means that according to these claims additional grants for patents are rendered absolutely impossible. Indeed, there is no lead accumulator which does not in one way or another touch the patent of Faure. But Faure himself claims many things which Planté invented years before him. Faure smeared an oxide of lead upon metallic plates, and oxides of lead form an important part in all modern secondary batteries; yet as regards the general efficiency and utility of storage batteries there is as great a difference between the original Faure cell and a good modern cell as there is between Hedley's "Puffing Billy" and the present passenger engine. We have never seen a secondary battery made according to Faure's description which has given satisfaction; we give him credit, however, for having "vulgarised" (this is to be interpreted in the French sense) the storage battery.

Dr. Hoppe gives a list of 92 patents on accumulators which were granted by the German Patent Office between March 1878 and November 1887. Confining himself to German specifications he was evidently unaware that oxides and salts of lead as well as perforated lead plates were used by Kirchhoff, in the United States, in 1861, and the same materials were suggested by Pulvermacher of London in 1869.

Subsection A brings descriptions of accumulators made of metallic lead, among which is the original grid of Volckmar and the old Elwell-Parker cell, then those of Kabath, Bailly, Eliason and others, belonging to the Planté type. B, accumulators with lead and oxide pastes, comprising a large number, from Faure down to the most recent modifications. C, accumulators with various kinds of electrodes, lead or oxide of lead plates opposed to plates of different materials, as also cells in which no lead is used.

III. *Scientific investigations on accumulators.*—This is the most interesting and certainly the most important part of the whole work, as it treats of the behaviour of cells in general. The author introduces the subject by stating that each patentee is bound, as by a law of nature, to consider his own as the best, and that the figures given by manufacturers do not always satisfy the claim of outsiders, therefore he has to confine himself to a comparatively small number of disinterested sources, and he only uses the data of manufacturers in a few instances where no independent scientific tests were at his disposal.

Next to the original work of Planté the investigations of Gladstone and Tribe deserve the first mention, and the author opens the paragraph on the chemistry of secondary batteries with judicious quotations from the

writings of these *savants*. The important functions of sulphate of lead receive here the fullest consideration. The views of Gladstone and Tribe have been partly corroborated and partly modified by Dr. Aron, whose ideas are scarcely known on this side of the Channel; he replaces in a Planté cell the negative lead plate by a copper plate with the object of proving that sulphate of lead is formed on the negative electrode of a lead accumulator. With regard to the formation of sulphate on the positive plate, Dr. Aron's opinion differs from that of Gladstone and Tribe in so far that he says that this might occur through some secondary action independent of the discharge process. Yet Dr. Aron gives no positive proofs of his assertion. Peroxide of lead has a brown colour, the charged positive plate of Planté is "blue black," a substance for which Wernicke gives the formula $PbO_2 + H_2O$, but Aron prefers to define it as $PbO + HO_2$. From the theoretical point of view, says Dr. Hoppe, there can be no objection to Wernicke's formula, and it also agrees with Ritter's notion; as far as the theory of accumulators is concerned it would be well if this question were decided, and it is deplorable after so many researches that this question has received no solution; it belongs to the domain of chemistry. The author acknowledges the difficulty, but the problem of accumulators cannot be regarded as satisfactory until all the chemical uncertainties have been finally cleared up. All the formulæ on the reaction of storage batteries are more or less hypothetical.

The investigations on the *efficiency* of accumulators have at times suffered through erroneous notions. Such was the case with the first papers by Ayrton and Perry, and the report of the French Commission appointed to give opinions on the Faure battery in 1882. The word *efficiency* is frequently used in an arbitrary fashion, and Reynier has found, by his own reasoning and formula, an "efficiency" of 81.9 per cent., where in reality it could only have been 66.8. The expression has long been used in engineering problems to denote the quotient between *work* expended and *work* returned, therefore there should have been no misunderstanding as to its meaning, but enthusiasts were wont to express the efficiency of batteries in terms of ampère hours, leaving at the same time the impression that this referred to the actual return of energy. Dr. Hoppe discusses this question at length and distinguishes between electrical efficiency, mechanical efficiency, and efficiency of chemical action. A number of influences come into play when charging or discharging. The E.M.F. of a lead and peroxide of lead couple is 2.2 volts; any variation in E.M.F. during the charge or discharge can only be caused by a change in the electrodes. Whilst charging the E.M.F. may rise as high as 2.9 volts when the negative plate is covered with hydrogen. As soon as this gas is removed from the surface a drop to 2.2 volts must take place, and the E.M.F. is further diminished to 2 or 1.9 when a partial oxidation of the negative plate commences, and this potential is maintained for a considerable time. In practice, we have to remember that the liberation of free gases denotes either saturation of the plates when fully charged, or that the gases are developed at too rapid a rate, in other words, that the surfaces of the plates are too small. From such observations the best current rate can be determined. Assuming that the proportions of plates and currents have been determined to give a maximum useful effect, then comes the further question of slow oxidation on the negative plates when the battery stands idle for a long time after charging; such oxidation reduces the E.M.F. below its normal value, which may further be diminished by local action on the positive plates. However insignificant these interferences may be in well arranged cells, the discharge should always take place soon after the charge when efficiencies have to be ascertained. Under very careful treatment and in a well appointed laboratory it is possible to obtain efficiencies of from 87 to 92 per cent.

Prof. von Waltenhofen calculates the capacity of an accumulator from the calories of bodies, and in one of

his papers he bases the calculation on the existence of litharge on *both* plates. This, however, can only be the case with Reckenzaun's accumulator, but the fact is recommended as worthy of attention. For the calculation of various combinations the author appends a table of calories for many substances. Now follow a series of results on such accumulators which have found practical applications; first, among these stands the productions of the Electrical Power Storage Company. The technical commission of the Vienna Exhibition testified to the high efficiency obtained with these cells a few years ago. Prof. Rühlmann gives a report of more recent experiments with this accumulator. Prof. Kohlrausch investigated the cells of Huber in Hamburg who manufactured E.P.S. cells under license, and his figures correspond with those of Rühlmann.

The accumulators of Farbaky-Schenek, Reckenzaun, and Julien were subjected to most exhaustive tests by Prof. von Waltenhofen in Vienna, and his conclusions form an interesting addition to the literature of storage batteries. Dr. Hoppe reproduces these in a condensed form. Mr. Preece's experience with Elwell-Parker accumulators is given, also Professor Dietrich's on the Khotinsky cells, the Philadelphia Commission on the Brush accumulator, Professor Kohlrausch again on the Tudor accumulator, and finally some data on the Lithanode battery prepared by Henry Lea, of Birmingham.

IV. *The industrial application of accumulators.*—This part gives a superficial account of many industrial applications of storage batteries, such as electric lighting of houses and railway trains, for laboratory and medical purposes, in telegraphy, deposition of metals and electric welding, and finally, for the propulsion of electric motors on tramcars and launches. Dr. Hoppe owns that he does not belong to the enthusiasts, that he has no prophecies to make, and that the immediate future will decide their fate; but that the adverse opinions on storage batteries, which are still held by some engineers, must now be considered as unjustified, since decidedly good results have been proved. A great deal of useful information has been crowded into a comparatively narrow compass by small print, and the value of this book would have been enhanced by a more liberal use of illustrations.

Geschichte der Transformatoren. VON F. UPPENBORN.
München und Leipzig: R. Oldenbourg.

This so-called history of transformers looks very much like a weak imitation of Rankin Kennedy's little work on "Electrical Distribution by Alternating Currents and Transformers," and the only reason which we can assign for its production is that it has been inspired by somebody interested in the Zipernowsky, Deri, and Blathy system. From nearly all points of view it is inferior to Kennedy's modest treatise, and the author entirely overlooks the work done by such men as Ferranti, Westinghouse, Mordey and others. His main object seems to have been to try to impress the reader with the idea that the first named trio are entitled to the credit of having solved the problem of electrical distribution by transformers, and we can only wonder that a gentleman of Herr Uppeborn's reputation has cared to father such an imperfectly developed and prematurely delivered offspring as that under notice.

City and Guilds of London Institute Old Students Association.—A general meeting of this association will be held on Wednesday, December 5th, at 7.45 p.m., at the Central Institution, Exhibition Road, S.W. (near the South Kensington Railway Station). The following paper will be read: "Aluminium," by W. M. Heller; and the following subjects will be dealt with in the paper: (1) History of the metal; (2) Its chemical process of production; (3) Its electrical process of production; (4) General physical, chemical, and mechanical properties of the metal; (5) General properties of its alloys; and (6) Its industrial applications.

SIR DAVID SALOMONS'S RESISTANCE GOVERNOR.

THIS instrument has been designed by Sir David Salomons for use in connection with the well-known repulsion regulator, and is made by the Woodhouse and Rawson Electric Manufacturing Company under his patents. It is intended for automatically introducing or withdrawing resistance from a circuit in case of an alteration of E.M.F., and in its mechanical construction is similar to that of the Porte Manville governor. The ratchet wheels are driven from any convenient rotating shaft, and, on an alteration of the E.M.F., an electro-

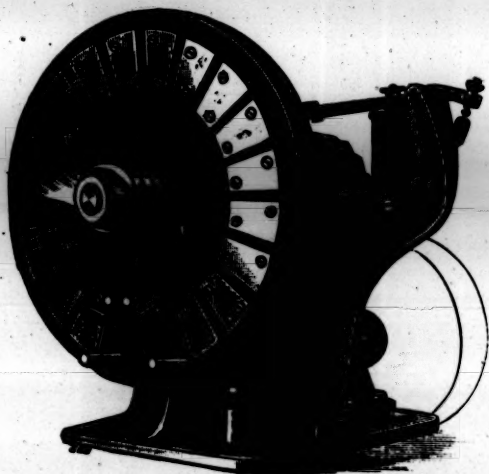


FIG. 1.

magnet draws one of the pawls into gearing with the ratchet wheel below it, causing the brush to move on to an adjacent contact, and so on till the proper E.M.F. has been reached by addition or subtraction of the necessary resistance. In case of the brush being carried right round to either extremity of the contact pieces circuit is broken by its pressure against the contact pins.

Fig. 2 is another form of instrument designed for the

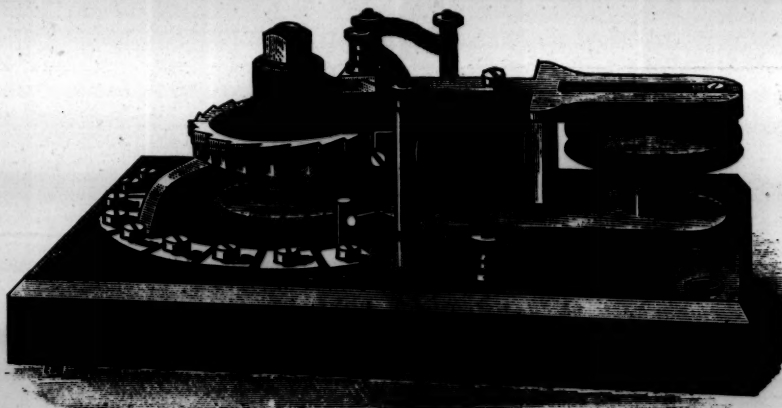


FIG. 2.

same purpose. In this the ratchet wheels do not revolve from the shaft, but the brush is given a step-by-step movement on the action of the electro-magnets, combined with the motion of the anchor escapement, which is mechanically driven from a shaft.

ELECTRIC LIGHTING EXCITEMENT IN KENSINGTON.

THE subject of electric lighting is at present causing great agitation in Kensington; but if the excitement be allayed, and a practical policy be adopted, the

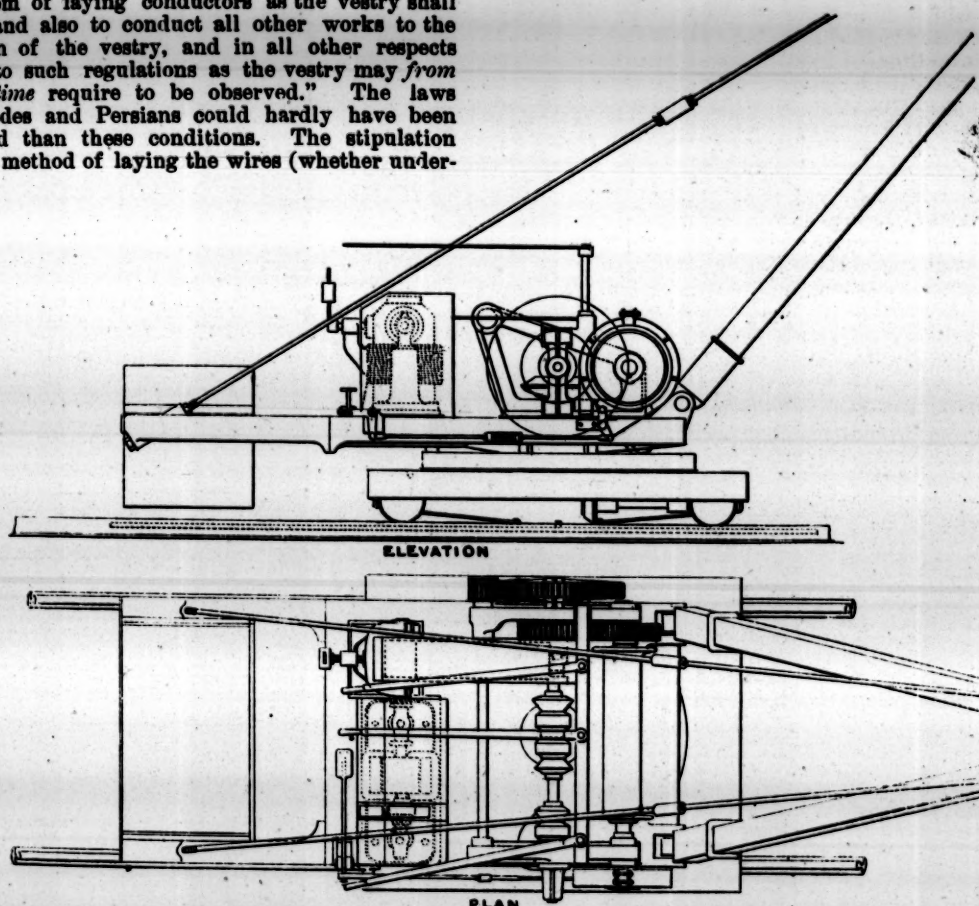
"Royal Court suburb" bids fair to be one of the best illuminated districts of the metropolis. For some considerable time past the inhabitants have been flooded with circulars from various companies seeking their support, and on one occasion a dispute, to which we referred at the time, arose between two of the companies, culminating in threats of legal proceedings. We have not heard that matters actually reached that point, but the whole question has been kept burning, much to the misery of the householders. At last, however, something like a climax has arrived, and must be settled one way or the other if anything is to be done in the next session of Parliament. The matter now stands thus:—A year or two ago, in anticipation of applications by electric lighting companies, the Kensington vestry appointed a special electric lighting committee to watch the progress of affairs, and in due time to report to the vestry. So far so good, but that "due time" did not come, in the opinion of the committee, until a fortnight ago, and then the report upon which so much depended was drawn up all in a hurry, on the very eve of the vestry meeting at which it was to be presented. It is not surprising that the document was brief and general in terms, and sadly wanting in particulars and reasons which would naturally be looked for upon a question of so much importance. The sequel, when we come to it, will be found to be highly instructive, if not amusing, considering the limit of time for companies to take the first steps towards Provisional Orders and Acts of Parliament. Meanwhile, it may be mentioned, the local papers were largely occupied by notices of an intention to apply for such Provisional Orders, although the necessary consent of the vestry to such applications could not have been received. It has not yet been received, but that is the affair of the advertising companies.

Originally seven electric lighting companies applied for the approval of the vestry in going to the Board of Trade, viz.:—The House-to-House Electric Light Supply Company, Limited; The Kensington Court Electric Lighting Company, Limited; The Notting Hill Electric Lighting Company, Limited; The Metropolitan Electric Supply Company, Limited; The Chelsea Electricity Supply Company, Limited; The London Electric Supply Corporation, Limited; and The West Middlesex Electric Lighting Company, Limited. These

requests were of course considered by the committee. For some reason not explained the West Middlesex Company was at once ruled out, and representatives of the other companies were invited to confer with a sub-committee to explain their views and proposals. Having, as they stated, obtained information (which was not presented in the report) respecting the respective systems of generating, storing and conducting electricity, the preventives the companies are prepared to adopt to avoid or modify nuisance from smoke, steam, and noise, "and also as to the financial position of the several companies," the committee decided against the last three companies, and recommended that permission

to apply for provisional orders be given to the four first, viz., the House-to-House Company, the Kensington Court Company, the Notting Hill Company, and the Metropolitan Supply Company. Why this selection no one knows except the committee. Then it appeared that the committee, in the same arbitrary manner, mapped out the whole parish into four (presumably) equal parts, and allotted each quarter to such company as it thought fit. Upon this came a startling piece of advice, in view of the experience of the last six years. Harking back to the Act of 1882, which is regarded as having seriously retarded the progress of electric lighting in this country, the committee recommended "That such consents shall be withheld until the respective companies have entered into a binding agreement with the vestry, by which the vestry shall be at liberty, if they so desire, to acquire the plant and interests of the said companies at the end of 21 years at a price to be fixed by agreement, or arbitration, in manner usual in such cases, and shall have bound themselves to adopt such system of laying conductors as the vestry shall approve, and also to conduct all other works to the satisfaction of the vestry, and in all other respects conform to such regulations as the vestry may from time to time require to be observed." The laws of the Medes and Persians could hardly have been more rigid than these conditions. The stipulation as to the method of laying the wires (whether under-

same helpless position as they are with regard to gas, and strong expressions were used as to the attempt to dictate to the inhabitants as to which supply they should take. It was further urged that the three companies excised should have been left in, and that all seven should be allowed to come in and compete, to the ultimate benefit of the public. The committee defended themselves in a feeble sort of way, their principal argument apparently being—as to the division and allocation—that it was necessary to so divide the parish because they could not allow a company to come in and "pick out a rich piece and leave the poor ones." No one took up the 21 years' limit, but perhaps the vestry do not appreciate the point. In the end the whole subject was postponed for a fortnight, the parish being left in a state of bewilderment and continued agitation. The four companies chosen by the committee have in the meanwhile advertised their intention to apply to the Board of Trade for provisional orders.



AN ELECTRIC CRANE.

ground or overhead it may be supposed was meant) may be reasonable enough, but the 21 years' limit—the "old iron" clause—is a retrogressive proposal hardly likely to secure the best system, while the condition as to compliance with fitful regulations is one to which the companies may be expected to demur somewhat strongly.

The members of the vestry having only received their copies of this report at the hour of meeting had little time to study it, but some of them very promptly grasped its peculiarities and at once declared that it must "go back," one gentleman improving upon the old adage by describing the matter as much too important to be decided at the "twelfth" hour. There was a general opinion as to there being too much haste, but the main point of objection and criticism was the arbitrary division of the parish and allotment of the pieces. This was condemned as calculated to create fresh monopolies, and so to leave the people in the

A PORTABLE self-propelling crane has recently been constructed by Messrs. Crompton & Co., and is now in use at the works of Messrs. Hermann & Co., at Dod Street, Limehouse. This crane was ordered to do the following work:—To raise 15 cwt. as a maximum load, to raise 10 cwt. at the rate of 80' a minute, to travel along a curved track at the rate of 80' a minute, and to slew at about the same speed. It was further specified that hoisting and slewing had to be accomplished under the terms of the specification, at the same time, and travelling and slewing had also to be accomplished conjointly; but it was not required to hoist, travel, and slew all at once. Each of these movements—hoisting, travelling, and slewing—are actuated off the same motor by a lever, as will be seen from the accompanying sketch, and these three levers in combination with a foot brake, are all easily controlled by

one driver. In carrying out the design and construction of this crane Messrs. Crompton have been ably assisted by Mr. Hollick, acting on behalf of Messrs. Hermann. After the crane was completed and erected many points of detail in construction were found to require slight modifications, and in all these points Mr. Hass, who is Messrs. Herrman's representative, gave further able assistance, the result in the end being eminently satisfactory. Not only has the specification been completely complied with, but the requirements therein set forth have been considerably exceeded. The crane is easily able to raise 18 cwt., and hoisting, slewing, and travelling can, if required, all be accomplished at once. The crane has now been in constant use for nearly two months, and Mr. Hass informs us that it has worked to his entire satisfaction. We understand from Mr. Hass that the sole reason why he was driven to use an electric crane was the fact that the insurance offices declined to renew his policy if a steam travelling crane were placed in the position which is now occupied by the electric crane. The motor is wound as an ordinary shunt motor, but there is an addition of a resistance which takes the place of a main winding outside the shunt. This is only put in circuit at starting, to ensure the magnets being fully excited, and to prevent the possibility of burning the armature until it has reached a proper speed. The brushes of the motor are arranged in the ordinary way, like dynamo brushes, and the direction of running is never reversed, the to and fro movement being arranged by means of clutches, &c. The arrangement of gear on this crane would be most readily applicable to derrick cranes and many other kinds of hoisting gear, travellers, &c. It is obvious that there is a great saving of wear and tear in these electric cranes, as compared with the ordinary portable steam apparatus, and the success achieved in this instance will, we hope, be the means of bringing electricity prominently to the fore in yet another direction.

LEGAL.

Thomson v. Batty.—Before Mr. Justice Kekewich, Saturday, November 24th.—This action was brought by Sir William Thomson against Mr. William Batty, an optician and compass maker, carrying on business at 39, Custom House Arcade, Liverpool, to restrain the infringement of the plaintiff's patent (No. 1,339 of 1876) for "Improvements in the mariner's compass, and in the means for ascertaining and correcting its errors." The invention consists and has for its object—(1) With smaller needles than in the compasses formerly in practical use to obtain as long a period of free oscillation as is suitable for working well at sea; (2) smallness of frictional error; (3) improved gimbals for supporting the compass bowl to give sufficient steadiness, and to leave it greater freedom to take up as nearly as possible the true level; (4) practical methods for applying correctors for the quadrantal, semi-circular, and heeling errors; (5) an improved appliance to the compass for taking magnetic azimuths of sun, moon, or stars, or terrestrial objects, without being impeded by the quadrantal correctors; (6) improvements in the method of correcting the compass by observation of the sun, moon, or stars, on a detached azimuth circle. The defendant set up the usual defences in patent actions. The Attorney-General (Sir E. Webster), Mr. Aston, Q.C., and Mr. Bousfield were for the plaintiff; and Mr. Phipson Beale, Q.C., and Mr. Chadwyck Healey for the defendant. From the evidence it appeared that Sir William Thomson had adopted a compass-card much lighter and larger in circumference than the Admiralty card formerly in use; that after some opposition and delay it had been adopted and successfully used in the Royal Navy, and on numerous large ocean-going steamers; and that it had acted most satisfactorily when heavy guns were fired—especially at the siege of Alexandria, when the firing made it impossible to work with the ordinary long magnet heavy card then ordinarily used aboard Her Majesty's ships. Besides the plaintiff, Sir F. Bramwell, Mr. Inray, and other scientific witnesses, several naval officers and other nautical men spoke in favour of the plaintiff's compass, and were cross-examined by the defendant's counsel—one of whom displayed his experience, not only as a member of the Bar, but as a yachtsman and the holder of a commission in the Naval Reserve. Witnesses were also called on behalf of the defendant, at the conclusion of whose case his lordship delivered judgment in favour of the plaintiff. Mr. Justice Kekewich, in delivering judgment, said that, apart from the application of the two cards—that of the plaintiff and that of the defendant—with a view to advantages of correction, &c., the two cards were for all

purposes substantially the same. As the Attorney-General had said, infringements of patented articles were not always exact copies. Whereas the centre part was, in the plaintiff's compass, connected with the circumference by a series of threads, in the defendant's compass the connection was by four wires which, instead of being horizontal throughout, were bent so as to give elasticity, and his compass presented a different appearance from that of the plaintiff. His magnets also were slightly different in form and position. These were the only differences between the two compasses. If the plaintiff was right with regard to his patent privilege, there had been a colourable imitation by the defendant which ought to be restrained. His lordship was, therefore, in the plaintiff's favour on the question of infringement. He was also of opinion that the plaintiff's invention was the proper subject of letters patent. Grey's and Keen's patents, on which the defendant had relied as showing want of novelty, did not lead to that result. A paper read by the plaintiff in 1874, before the British Association, with regard to his invention, was not evidence that the plaintiff had anticipated himself. On all grounds he was entitled to the protection of the Court. His lordship accordingly granted an injunction to restrain the infringement, ordered the defendant's compass cards to be given up to be destroyed, and gave the plaintiff the costs of the action on the higher scale. At the suggestion of his lordship, Sir William Thomson consented not to press for an inquiry as to damages.

Gouraud v. Fitzgerald and Others.—(Before the Master of the Rolls and Mr. Justice Lopes).—This was an appeal of defendants from a judgment of Mr. Baron Pollock and Mr. Justice Manisty, setting aside an order made in Chambers for delivery of particulars.—Mr. Reginald Brown, with whom was Mr. Finlay, Q.C., appeared in support of the appeal, and Mr. Moulton, Q.C., and Mr. Lawson Walton appeared in support of the decision of the court below.—This case raised a question as to the obligation of parties to give particulars, especially in actions of libel. The plaintiff was chairman of several telephone companies, and among others at one time of the Consolidated Telephone Company, and the defendants were some of the members of a committee of investigation appointed in June, 1884, by the shareholders to report upon its affairs. The plaintiff complained that in a report issued and circulated in July, 1884, the defendants published libellous statements of him. The defendants denied that they had published or caused to be published the report complained of, and submitted that the alleged libels were contained in reports by the committee upon the affairs of the company to their fellow-shareholders, and were made and published to them *bona fide*, and that the other statements complained of were contained in a fair and correct report issued to the shareholders by order of the directors, and that, therefore, they were protected. An order had been made "that the plaintiff deliver to the defendants particulars of the publications, if any, which he intends to rely upon, other than the reports to the shareholders." But the Divisional Court set aside that order, being of opinion that the particulars were unnecessary, and ought not to be allowed, on the ground that the case related to publication of a specific document, as to which the defendants could have no difficulty in ascertaining to whom it had been sent, hence the present appeal.—Their lordships now affirmed the judgment of the court below, and dismissed the appeal with costs.

COMPOUND-WINDING PATENTS.

KING, BROWN & CO. v. ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.

LORD TRAYNER, on Tuesday, in the Court of Session, Edinburgh, heard proof in an action at the instance of King, Brown & Co., Rosebank Electric Works, Broughton Road, Edinburgh, against the Anglo-American Brush Electric Light Corporation, Limited, 6, York Place, Edinburgh, for reduction of letters patent granted in October, 1878, for improvements in apparatus for the generation and application of electricity for lighting, plating, and other purposes. The pursuers say that in the patent there is no ingenuity or invention displayed, and the specification is discordant to provisional specification, and claims an invention different from that disclosed there. There is no sufficient distinction between what was in use or known prior to the date of the letters patent, and what was new or claimed as new by the alleged inventor. The defenders have repeatedly threatened pursuers with legal proceedings and liability in respect of the manufacture of the alleged invention said to be covered by the letters patent, and in particular of compound wound dynamo machines. This, they say, has seriously affected their business, which is entirely in Scotland, and in the circumstances the present action is necessary. The defenders say that the pursuers' machines are infringements of their letters patent, and that the pursuers' averments are unfounded in fact.

Mr. Graham Murray and Mr. C. Dickson appeared for the pursuers, and the Dean of Faculty (Mr. Mackintosh, Q.C.), and Mr. Jameson for the defenders.

JOHN IMRAY, M.I.C.E., M.I.M.E., manufacturing and consulting engineer, was the first witness called. He described the general principles of dynamo machines, the action of the currents on a

single loop of wire and in a coil of wires, the object of the commutator and its arrangement on an armature of many loops. He then explained the stages through which methods of generating electricity had passed until finally he said it came to this, that they were able to supply electricity from that produced by the machine itself. Shown a model of a dynamo (series-winding) he pointed out the action of the machine. The weakness of the machine lay in this: that as soon as they broke the external circuit they ceased to have an electric machine because there was then no current. In electrical language that was spoken of as having the electric circuit open. A model of a shunt-winding dynamo was shown, and witness said the strong point of this machine was that whether the external circuit was open or closed, the dynamo was always capable of producing magnetism. Its weak point was the loss of a certain amount of electricity. Witness described the action of a "series-shunt" or compound winding dynamo, the advantage of which was that, having two coils upon the magnets, when they changed their work in the outer circuit they also changed their current in such a way that the one pretty nearly compensated for the other. Witness had prepared himself to give evidence by examining the Haddan specification as amended and displayed and also Mr. Varley's specification. Haddan's specification was divided into four general divisions (1) general form of dynamo electric machine, (2) a peculiar revolving armature, (3) a peculiar commutator and (4) a peculiar disposition of wires. Taking the original, he found that the provisional specification mentioned three divisions and a fourth division which was afterwards cut out. The three divisions were (1) the construction and use of the armatures; (2) the construction of commutators; and (3) the particular arrangement of the wires. Looking at the provisional specification he saw only one invention foreshadowed—the construction of the commutator with bearing segments attached in a particular way. Commutators were very old at the date of the patent, 1878; they had been in use from the very first almost of electric magnetic machines. Turning to the patent as amended in this claim he found that the second claim was almost word for word the same paragraph as appeared in the provisional specification, and claims 3 and 4 were claims of particular arrangements shown in the drawings. Shown a model of a commutator with an insulating segment (r) witness deposed he could find not the slightest hint of the arrangement in the provisional specification. It was a perfectly different and distinct apparatus, and it had a different and distinct object from the object which was served by making sub-segments of a commutator detachable. In claim 5 there was a claim for a particular arrangement. Instead of making the insulating segments all insulated they were joined on to the adjoining segments of the next brush. He found no hint of that in the specification. Comparing claim 6 with the provisional specification, he found no allusion in the latter to the insulator, r. The commutator, as he had stated, was old. In his view there was no invention in separating the segments of the commutator into two bits and then putting them together with a screw. It was a common expedient in almost all kinds of machinery. Practically in this commutator—and leaving out of account the insulator, r.—there was nothing more than a division into two bits which was afterwards bound with a screw. Shown a commutator which was made and used in Manchester before the date of the patent, witness deposed that it could be properly described as a commutator in which sub-segments were in proper electrical connection, while there was another exterior segment attached to a sub-segment by a screw or other mechanical device and making a wearing surface. It was, in fact, a combination of sub-segments, wearing segments and screws. Shown a second commutator, used also before the date of the patent, he said it differed from the first only in that the screws were within instead of outside. The date of the original specification was 1878, and at that time practically the incandescent light had not come into use. The proper form of material for working the light had not been discovered. Almost the only lamps in use were the arc lamps, and nearly always there was only one lamp to one circuit; that was to say, each lamp had its own dynamo machine. Seeing that that was so, he found no indication in Brush's specification of application in the machine which he was describing to the purposes of electric lighting at all. Witness then described the process of electro-plating and the difficulty which Mr. Brush sought to overcome, described at considerable length in his specification. His object was that whether the bath was more or less powerful or whether it was cut off altogether, there should be a permanent field in his machine of sufficient strength to resist the action of the bath. Accordingly in the specification as originally drawn out witness found a claim which was now made the claim for a dynamo electric machine. He found that Mr. Brush claimed proper shunt as well as series shunt. The description on page 23 was that his object was attained by diverting from external work a portion of the current of the machine and using it either alone or in connection with the machine for working the field magnets. If used alone it would be a simple shunt. Figure 5 corresponded to this and showed the proper shunt. Supposing a machine to be shunt wound or shunt series wound and to attain thereby a certain power of self-regulation, it did not necessarily follow that there was a constant potential upon such a machine. That depended entirely on how the wires were proportioned. In a pure shunt you never had a constant potential. For electro-plating there was no particular necessity for having a constant potential. On the other hand for electric lighting you were liable to a very great deal of difference in the resistance. An incandescent lamp required a certain tension. If too low you got

a reddish light, and if the tension was too high you probably destroyed your carbon.

Mr. GRAHAM MURRAY: Do you find in Brush's specification the slightest indication, first, of the observing a constant potential, and second, of giving the means by which it is secured?—No. I find no hint of it. He did not think it could have suggested it at the time. In fact there was no call for it at that time. It was about 1882 or 1883 that the practicability of it originated.

If a machine was made in accordance with the description in Brush's specification would it be quite possible to arrange it according to the series shunt plan of winding and yet make it a non-constant potential machine?—There might be a condition in which it would be self-regulating and there might not. The machine might be self-regulating to a certain extent, in this way, that it would produce more current when there was more work to do, and yet not be a constant potential machine. In Mr. Varley's specification a part of the electricity developed was diverted to maintain the magnetism and the remaining force to produce the electric light. It was the case that in the series shunt the circuit of the larger resistance was always closed; that the circuit of less resistance was used for the electric light; that when the electric light was being produced the greater portion of electricity passed through the circuit with less resistance; that that greater portion which passed through the circuit of less resistance maintained the magnetism in the magnets and produced the light; and that in the series shunt arrangement that when the electric light circuit was open, the electricity developed passed through the greater resistance. At the time when Mr. Varley's specification was written, it was quite common to use the word electricity as equivalent either to electric current, which was one thing, or electric energy which was another. Even yet the term was used. If the word electricity in this specification was read as electric energy literally, the phrase meant that part of the electricity was diverted to maintain the magnets and the remaining portion to produce the electric light. In maintaining the magnets there was a definite consumption of energy. This was an exact description of the series shunt. It was suggested that what Varley there described was not a series shunt but what was called a double shunt arrangement. This was not consistent with the description. If there was a double shunt arrangement there would require to be three circuits altogether. In this description there were only two sets named. If this was a double shunt arrangement, it followed that what Varley called the electric light circuit was a second shunt. In Varley's time, the series form of winding was very well known and the shunt winding also. It was quite a simple thing to put the two together, and that, so far as he could see, was done in this instance. It was clearly described, at any rate. Varley gave no indication of the different resistances that were to be apportioned to each, but he stated that the shunt wire was to be of greater resistance than the other. He did not find anything in Brush's that was not disclosed in Varley's. The very same words applied to described each. Brush said: "I obtain my object by diverting (the same word) a portion of the machine and using it either alone or in connection with the rest of the current for working the two magnets," either the pure shunt or with the rest of the current, the series shunt.

Cross-examined by the DEAN OF FACULTY: Is compound winding not a great improvement upon series winding or shunt winding?—At that period there was not much call for it. Now it is of great use.

Was it not in 1878 a distinct improvement?—Yes, in 1876 it was.

Then compound winding, you say, is disclosed in Varley?—Yes. But you don't dispute that compound winding is also disclosed in Haddan?—It is.

The previous machines were series machines or shunt machines.—Yes.

The series machines had serious faults. One of these was that it gave too little pressure when few lamps were used?—No. The real difficulty was this, that when the outer circuit was open there was no electricity.

In the series system when the resistance was increased, the series system yielded too little pressure, and therefore too little magnetism was produced?—No doubt that would have been the result, but that was not the fault which was then felt.

The shunt machine, when the resistance was great, gave too much pressure, or an unnecessary amount of pressure, while, on the other hand, when the resistance was slight, it gave too little pressure, so that both these machines were unsatisfactory in these respects?—Not at that period. At that time these wants did not exist. The only unsatisfactory part was this, that if you had a series machine and applied it to electro-plating, as soon as your outer circuit was broken, you lost your field.

Is it the case that the compound shunt-wound machine tended to compensate for these defects?—No doubt you could compensate by the series shunt. The series shunt machine in compensating these defects, did so by tending to produce what was called constant potential.

If you had a compound machine with proportions of the wires carefully adjusted you would produce constant potential almost invariably?—No. Approximately; sufficiently near. The degree of approximation would depend upon the proportions.

Apart from particular proportions I suppose I may take it that the shunt machine tended to produce constant potential more or less according to the excellence of its proportions?—No doubt.

And that was a distinct improvement whether at that time so valuable as now may be open to question. Now compound

winding having that character, do you dispute that Haddan's specification describes a system of compound winding?—It describes the system of compound winding as also the system of shunt winding.

I suppose I may take it that it describes it so that a workman of ordinary skill would, if he followed the direction of Haddan's specification, construct necessarily a compound winding machine?—He could.

And the machine so constructed would tend to what we have called constant potential more or less approximately according to the proportions used?—No doubt.

Now in Varley's specification there was nothing of this particular alleged improvement. Haddan, however, has a number of drawings showing different forms of his compound winding. If you examine drawings carefully you might measure the proportions of the wires in the circuit of less or greater resistance?—You cannot because you have no scale to go upon.

If you take your compass and take the volume of the circuit of less resistance as shown on the drawings and take the volume of higher resistance and compare them, what proportion do you get? You cannot get this because you do not know what amount of insulation you have. A workman following the drawings would make the shunt circuit of very high resistance in proportion to the series circuit, that was to say a coil of very high resistance in proportion to the series coil. In some particular cases a workman taking the letterpress and drawings would strike a machine tending to constant potential, and also to produce a pretty close approximation to constant potential. The number of lamps used would affect the parallel.

Would you not get such self-regulation as would keep the pressure of the machine constant whatever that pressure was at the start?—No.

Would you not get an approximation to that pressure?—No excepting in some particular circumstances.

His LORDSHIP: In the abstract it would not produce that, but it might in certain concrete cases?—Yes.

The DEAN: What additions to the specification in the letterpress and in the drawings would tend to produce it under all circumstances?—The electrician having before him the problem to connect a certain number of lamps, at certain distances, with a certain velocity of machine, a certain size of machine, and length of leads, would then be in a position to compute pretty clearly what the proportion of circuit would be in order to get constant potential. Having determined the proportion between the two sets of wires, you could no doubt get an approximation of constant potential. He had not worked out the problem whether taking the proportions in the drawings and the letterpress, the machine so constructed would tend very substantially towards constant potential; but he thought it likely, under certain particular circumstances, that a machine so constructed did produce a close approximation to constant potential. The passages which he founded upon as describing a compound winding machine were in Varley's specification of 1876, and in his provisional specification.

The DEAN OF FACULTY: Is there any claim applicable to compound winding as so described?—No.

Is there any drawing of a compound machine?—No.

There is a machine, is there not, of a series winding character?—Yes. The main object with Varley was to keep up a permanent magnetic field.

Is not the improvement, which you said was to assist in developing magnetism and electricity, an improvement which is now recognised as impossible?—Well, no; I do not think it is recognised as impossible. The language used is now very different.

Isn't it well recognised that Varley's main improvement as described in this specification involved an electrical absurdity?—I am not aware of it.

Was it not Varley's idea that you could store magnetism while the bobbin was passing along the face of the pole plate, and before you could begin to produce electricity?—I believe it was some idea of the kind.

Isn't that an electrical absurdity?—It is now recognised that you cannot produce magnetism without involving electricity.

Isn't the whole specification occupied with describing machines having that object except the passage on which you rely, and the description of the lamp?—And the description of a meter.

Is there any way, now, of storing magnetism without producing electricity?—No.

Confine your attention to the sentence: "Part of the electricity developed by a machine is developed to maintain the magnetism of the magnets, and the remaining portion is used to produce the electric light." Is not that a quite correct description of the ordinary shunt machine?—It will describe a shunt machine.

And anybody reading that passage by itself would understand that a shunt machine is meant?—If he did not know of anything else.

If he confined himself to the passage?—No; the passage includes also the other.

Would not the passage taken by itself suggest to any man acquainted with the subject a shunt machine alone?—No doubt it would, because at that time the other machine was not known.

Isn't it a characteristic of compound winding that the whole of the current shall be employed in maintaining the magnetism of the magnets?—Yes.

Isn't it a characteristic, on the other hand, of the shunt machine that only a part of the current is used in maintaining the magnetism of the magnets?—Yes, except in the case when the other circuit is open.

Is it not quite credible that in the passage I have mentioned

the whole of the electricity does not go to maintain the magnetism of the magnets?—Yes; only a part goes.

In short, the passage points to a division of the electric current, one discharging one function and one the other?—If you take that passage alone.

His LORDSHIP: You think, from what follows, that that is not his meaning?—That is not his meaning. It is not consistent with what follows.

The DEAN: Had Varley, in his previous patents, not disclosed a double winding on his magnets for certain purposes?—I do not know.

Is there anything to show that the electricity in the circuit of the larger resistance does not come from a separate part of the machine from that which supplies the electric light; is there anything to show that the electricity in these two circuits has a common source?—Certainly.

Will you point to anything which is inconsistent with this, that a separate part of the machine supplies the electric light for the excitation of the magnets—that a separate part of the machine supplies the electricity for the circuit of larger resistance, and that another and separate part of the machine supplies the electricity for the circuit of smaller resistance?—He is dealing with the electricity developed by the machine; you might bring the machine to work that way.

His LORDSHIP: The Dean of Faculty asks you whether there is anything in this specification inconsistent with the idea that separate parts of the machine generate electricity for separate purposes?—No, it is not exactly inconsistent, because you might drive the machine in that way.

But there is no description given whatever to indicate that that was part of his intention?—Quite so.

The DEAN: Were machines known at that time which had two circuits, one for exciting the magnets and the other for doing the work?—They were generally separate machines. It was not common to have machines with two circuits, but there were cases.

If you had bobbins for exciting electricity, one set of them told off to excite the magnets and the other to do the work, that would be separate excitation?—Yes.

Have you examined Varley's specification and drawings sufficiently to say whether that was not the arrangement which he had in his mind?—I do not think it was.

Can you point to any passage in the specification or any figure in the drawings which is inconsistent with that mode of working this machine? In all the drawings of this machine which have multiple bobbins you could connect in such a way as to do that.

You have examined Varley's machine produced in court. Could it not be connected up so as to work a separate excitation in the way I have described?—I think it might, because there are ends of the different wires which are in the loose that might be connected in various ways.

You negative the suggestion that Varley's language would be satisfied by what had been called the double shunt arrangement?—Yes. By that I understand the magnets to be double-coiled and both receive their electricity from the terminals.

Take from me that you have, first of all, a portion of the electricity diverted to form a shunt of the usual kind and then that the rest of the electricity goes off on an alternative path and the external circle diminished only by the part diverted; but that before the electricity reaches the lamp at the electrode of the lamp there is a second shunt making an alternative path, whereby the second portion of the electricity is diverted and taken round the magnets forming a second closed circuit and thus producing the double shunt, leaving only the diminished portion of the electricity to do the work—have you ever seen a machine of that kind?—I do not know it at all.

Does not such a machine answer wholly the description upon page 8?—No.

Is your view inconsistent with the idea of the circuit of lesser resistance being diverted so that part of it may be used for the electric light and part of it returning again to the excitation of the magnets?—It is inconsistent.

You read the words: "used for the electric light," as if that read as wholly for the electric light?—Yes. There was another gentleman who said that when the electric light circuit was open the electricity diverted passed through the circuit of greater resistance only. From the description he gathered that the circuits could be used either alternately or simultaneously. It was not a feature of Varley's description on page 8 that the circuit of larger resistance was always closed. He described a lamp in which it was alternately opened and closed.

Is there not on page 8 a description of a circuit of larger resistance being always closed?—Yes.

Does that not point to the circuit of larger resistance being kept within the machine and not being turned to external work?—Yes.

On page 9 the circuit of larger resistance is described as taken outside the machine and brought round the helices of the arc lamp?—It is brought round the helices of the small motor, which is part of the arrangement of the arc light. It is always closed.

Is it always closed although it goes out of the external circuit to do that work?—Yes; it was working the motor. The circuit of these magnets did not open or close in connection with circumstances, and it was not liable to open more or less as the other external circuit. If that circuit was broken the motor could not be worked. He could not conceive of there being any breakage in the external circuit upon which the coil of greater resistance was. Line 27 of the description showed that the electric circuit

was made to open or close, but it was always kept closed. Varley specified that one of his coils was to be of high resistance and the other comparatively smaller. In the compound-wound machines, as presently used, there was a great difference between the circuit of high resistance and the circuit of less resistance. Haddan used the words "comparatively high resistance."

Mr. Haddan does not say merely that the resistance in the one is higher than the other. Does not that suggest to you that Mr. Haddan had in his eye a considerable disproportion between the two coils?—I do not think he had anything in view at all of that kind.

Now, about the provisional specification, I suppose you know that it merely sets out the nature of the invention?—Yes.

If the patentee discovers improvements upon his invention between the date of the one specification and the other he is bound to disclose them for the public benefit?—Yes.

Was there not a general description of Brush's commutator?—Yes; but I do not think the commutator described in the original specification is this one.

Are not the subordinate claims to which you take exception claims relating to improvements in mechanical details which go to aid the action of the commutator?—Yes; I suppose that is the intention.

Does not the provisional specification quite distinctly state that one of the objects of the invention is to construct commutators cylindrical? Is not cylindricality described as an object of the invention?—I should imagine not, because there were plenty of cylindrical commutators before.

Is not one of the objects described to construct commutators cylindrical?—No. He says: "We construct commutators cylindrical in this way."

Is it not the case that the claims to which you take exception, all of them tend to attain a more or less perfect cylindricality in the machine?—So far as they provide for wearing.

Was it not the case that in forming commutators you had blank spaces where you had insulators?—Yes.

And was not the effect of it that there was a break in the continuity of these cylindrical surfaces?—More of a break than there is now.

With the result that the brushes in going over the cylinders fell down into a hole and rose again?—The evil was this, that the material of which these spaces consisted having a different degree of hardness from the metal there was an inequality of wear. The operation claimed in the first claim was to make equal wear and nothing else. Of course the result of unequal wear was to make holes. It was not one of Brush's improvements claimed by them to diminish the number of those insulating air spaces which existed. Brush, by a peculiar connection of his bobbins, required a commutator which must have a considerable space non-conducting between his plates. He thus put in the blank space non-conducting material, and he guarded them by putting on conducting plates. The two commutators said to have been used in Wilde's (Manchester) work were identical. They had got the peculiar form of screw which on Mr. Haddan's drawings were indicated by the letter x. The insulator was on the shaft of the machine.

[Witness then examined a Wilde (Manchester) machine.]

The DEAN: Will you say that the hub was insulated from the shaft?—Yes.

Then you say those commutators before you were insulated from the shaft by means of the vulcanite or ebonite hub?—One of the segments must have been, because the shaft is used as the conducting wire.

Look at claim 2. The commutator is thus described: "Commutator cylinder consisting of an insulated hub or body to which are attached sub-segments." The hub there is attached, is it not, to the whole of the sub-segments?—Yes.

In Wilde's it is only attached to one of the segments?—Yes.

His LORDSHIP: Therefore, those commutators which have been brought from Manchester are not within the description of Mr. Haddan's claim?—I think so, my lord. The part that requires to be insulated is insulated; the part that does not require to be insulated is not insulated.

Further examined as to points of difference in the arrangements witness stated that the collar in Wilde's machine had not a means of attachment to the entire commutator.

Re-examined by Mr. DICKSON.—In Haddan's specification, from beginning to end there was no suggestion of constant potential. In order to secure that it was necessary to have a definite proportion between the lesser resistance and the greater resistance. There was no suggestion of any such proportions in Haddan's specification. Questioned as to the figures attached to the specification, witness said he had never in his experience known of drawings without scales being referred to as showing the relative proportions, and he pointed out instances of disproportion in the wires figured. There seemed to be as many differences of proportion as there were different figures. The screws in the Haddan commutator did not in any material way differ from those in the Manchester.

Comparing the two, do you find anything in the Haddan commutator which is not either actually or by itself mechanically or electrically equivalent in the Manchester commutator? It is substantially the same thing.

Mr. IMRAY's evidence having concluded, he left the box, and his lordship intimated that the hearing of proof would be resumed next day.

Mr. DICKSON: There is a gentleman from Manchester. He will be very short.

His LORDSHIP: I'll take him to-morrow at ten o'clock, and you can make him as short as you like, Mr. Dickson. (Laughter.)
(End of First day.)

Wednesday, November 28th.

The hearing of proof in the action for reduction of patent brought by King, Brown & Co., Edinburgh, against the Anglo-American Brush Electric Light Corporation, was resumed in the Court of Session on Wednesday forenoon. Mr. Graham Murray, Mr. Dickson and Mr. Daniel again appeared for pursuers, and the Dean of Faculty and Mr. Jameson for the defenders.

RICHARD MARRIOT, manager for a Birmingham firm of electroplaters and gilders, said his firm bought the commutator produced from Mr. Wilde, and rings of the pattern produced. Commutators with those wearing rings upon them had been in use at his place since 1870, but not continuously. The rings or wearing segments were the same as those on commutators 27 and 28 shown.

Cross-examined.—27 was a commutator identical with the one he submitted.

HENRY BOURNE, plater and gilder, Birmingham, said that in 1870 he bought from the works at Mill Street, Manchester, an electric machine which had in it the commutator produced. The outside rings had got worn off. Witness got a change of commutator about 14 years ago, the outside rings of which were detachable segments, fastened on by screws. He produced a commutator supplied by the same firm in 1874; it was the one he had in use. Commutators 27 and 28 were identical with the commutator he produced with the exception that they had copper rings outside while his were of gun metal.

Cross-examined.—The screws in 34 and 35 were fastened from the inside.

Re-examined.—That made no difference in the working of the commutators, but it was a great deal better to fasten inside for the reason that when fastened outside the heads of the screws wore off and there was a difficulty in replacing.

JOSEPH SHILBOCK, employed by Mr. Bourne for 17 years, gave similar evidence.

WILLIAM FREDERICK HOEDAY, managing clerk with the Electrical Engineering Company, Manchester, produced a book showing sales of the firm since 1863.

ROBERT MARSH, foreman of the fitting department of the Electrical Engineering Company, Manchester, in whose employ he has been since 1872, said he was familiar with the make of all the firm's electrical machines in all their details.

Mr. DICKSON: I show you Nos. 27, 28 and 35. Are these, or any of them, the forms of commutators which you have been making during the time?—Yes; they are all as we have made them. I could not swear to 28. That is the form in which we make them, but whether we made it or not, I could not say.

His LORDSHIP: Have you seen identically the same commutator in use or made in the works since 1873?—Yes.

Mr. DICKSON: Detachable segments are fitted on with screws from the inside?—Yes; much better from the inside, because in fitting them with screws from the outside the head would get worn away with the rings, and in fitting new rings on, the screw that would be left in these foundations would have to be drilled out.

I show you 34. Is that a commutator such as you have made, except that the detachable segments are not on it?—Precisely the same.

By Mr. JAMESON: Ordinary screws were used for fixing the segments. Would it be possible in that commutator (31 shown) to fix in the screws on the inside?—I do not see that it would be.

If you could fix as easily a screw from the outside as the inside, would not it be better to have it from the outside?—I think not.

If you had a screw with a long enough head, would not it be better?—No; for the reason I stated before.

If you could overcome that difficulty you have mentioned, would not fitting from the outside be more convenient?—It would, I think.

Dr. J. HOPKINSON, D.Sc., Lond., F.R.S., M.I.C.E.; and Senior Vice-President of the Society of Telegraph-Engineers and Electricians, was examined by Mr. GRAHAM MURRAY: You have for many years given special attention to electrical matters, and especially to dynamo-electrical machines?—Yes.

Have written several papers—and published them in the publications of the Royal Society—on dynamo-electrical machines?—Yes.

With a view to giving evidence, I think you have directed your attention to Brush's specification, or Haddan's specification of Brush's patent?—Yes.

Take the original one which details the provisional specification. What is the invention that is adumbrated, according to your view, in the sentence beginning, "Also the construction of the commutators?"—Simply the detaching of the segments of the outer wearing pieces, which can be removed as they wear away.

Turn to the complete specification as disclaimed and amended. Does claim 2 correspond with the claim that is adumbrated in the passage that I called your attention to?—I find not only does it correspond, but the words used are almost identically the same. It is precisely co-extensive with the matter foreshadowed in the provisional specification.

What is claim 3 for?—Claim 3 is a claim for the addition of certain screws for the purpose of attaching the removable segments.

In combination with wearing segments specially described?—Yes; the wearing segments, s and r.

What are claims 4, 5 and 6 for?—The fourth claim is for certain special segments, x.

Instead of calling them special, I would like the epithet applied to them?—Insulated. Five and 6 are developments of the same thing; 5 is for a particular way of attaching these segments r to the neighbouring segments s, and the 6th is for the omission of one or two segments from the commutator.

Do you find anything in the provisional specification that at all hints at the invention which is claimed in claims 4, 5 and 6?—Nothing whatever. I may say that in the provisional specification I find no mention of the screws, x. I find no hint of the insulated wearing segments, r; no hint that these segments may be attached to the neighbouring segments, s, and no hint that one of the segments, r, may be omitted.

What are the objects of the wearing segments, r?—They are to secure equal wear.

But in so far as they are insulated?—For the purpose of cutting out a section of the armature; disconnecting the armature at a certain period of the revolution.

Is there any disclosure of that in the provisional specification?—No.

At the date of Haddan's patent, 1878, were commutators old?—Oh yes.

As a matter of common knowledge, had commutators at that time some insulation in attachment with them?—In most cases the insulations was the cylindrical hub to which the segments of the commutator were attached.

Then do you think it is possible to read claim 2 as claiming as an invention a commutator cylinder in so far, first, as it is a cylindrical form, and second, as it contains an insulating hub?

The DEAN OF FACULTY objected, and his objection, that an attempt was made to prove anticipation otherwise than by instances of which notice had been given on record, although overruled was allowed to be noted.

The question having been repeated, witness replied in the negative.

HIS LORDSHIP: From your knowledge of the state of electrical science in 1878, in what way do you read claim No. 2?—The attachment of wearing segments to sub-segments connected with the wire of the armature.

MR. MURRAY: Has the commutator (No. 27) detachable segments?—Yes.

When in use, must it have had some insulating material to insulate one of the segments?—Yes. It is pretty clear, from the different size of the holes, that these segments must have been insulated from the shaft of the machine by means of an insulated hub. Apparently the other one has not been so insulated, but it has been in metallic contact with the shaft. I judge that from the difference in the size of the holes.

Would it make any conceivable difference, from an electrical point of view, if the insulating hub was any of these three things, either attached to the commutator, attached to the shaft, or left loose between the two?—Not a bit.

That commutator is one of merely two segments?—Yes; if we had a large number of segments we would introduce a ring between these two rings and carry that on to the hub prolonging the hub so as to reach the second ring.

Coming to the portion of Brush's specification which deals with the 7th claim. At the time of Brush's specification in 1878, what was the condition of electrical knowledge and practice as regards the incandescent light?—Incandescent lighting at this time was practically unknown.

When was the incandescent lamp discovered or arrived at in the form that made it practically useful?—Early in 1880—at the end of 1879.

What had been the difficulty that had retarded the discovery?—The knowledge of how to make the lamp.

What was it they did not know how to make in the lamp?—The carbon filament.

Until the discovery of the incandescent lamps was there any particular reason or object in having a dynamo machine which would maintain a constant potential?—There was no use for such a machine at that time.

In Brush's specification do you find any indication of a desire to have a machine with a constant potential or any indication of how such a machine is to be constructed?—No.

It does disclose too methods of winding?—Yes.

One of which is pure shunt and the other is series shunt?—Yes. Assume that a machine was made in accordance with Brush's specification and in accordance with that part of it which directs it to be wound series shunt, would it still be possible that that machine would not have a constant potential?—It would be exceedingly probable. You would want to know the speed of the machine before you could know if it would have constant potential.

What else would you require to know in order to have a constant potential beyond what is in the specification?—I have already said you require to know—taking the drawings for example—what scale those drawings were on and what speed the machine was to run.

HIS LORDSHIP: You require to know the difference in the diameter of the wire?—Quite so.

MR. MURRAY: Does getting a constant potential depend upon the proportion of resistance being accurately determined?—It depends upon the number of windings being accurately determined, and the determination will depend upon the speed of the machine.

As a matter of fact after a suitable lamp was discovered, who first began to make constant potential machines?—I really don't know. It must have been about 1881 or 1882 that they were first introduced or proposed. Then they very rapidly came into use.

What do you find Brush desires in his specification?—I find a desire to maintain the magnetism of his magnets even when the machine was doing little or no external work.

And do you find any particular reason why that is so?—He speaks of confining his machine more especially to electro-plating.

Now, turning from Brush to Varley's specification, do you find there the disclosure of a certain manner of winding?—Yes.

What is the manner of winding there disclosed, according to your view?—He discloses that he would wind in two coils, one a coil of higher resistance, the other a coil of lower resistance, the coil of higher resistance constantly in circuit so that whether external work be done by the machine or no, electricity should flow through it. The coil of low resistance is to be the electric light circuit itself. He therefore discloses a combination of the shunt coil and the series coil conspiring to magnetise the machine.

Does he disclose it in such a way that an ordinary workman could have made the machine?—I have not the least doubt about it.

Does he, any more than Brush did, disclose a mode of making a machine with a constant potential?—No; I don't suppose he or Brush had it in their mind at all that constant potential was a desirable or useful thing.

What is the light that has there been spoken of?—An arc light or a semi-arc light.

And is there provision for a certain form of lamp?—Yes.

In line 38 Varley says: "Part of the electricity developed by the machine is developed to maintain the magnetism of the soft iron magnets, and the remaining portion is used to produce the electric light." What part of the specification shows you that?—When he says the remaining portion is used to produce the electric light you are led to the conclusion that that portion, besides producing the electric light magnetises the magnet. He says here, in the beginning of the next paragraph, "When the electric light is being produced the greater portion of the electricity passes through the circuit of less resistance, which I term 'the electric light circuit,' maintaining the magnetism of the magnets and producing the light."

Explain how the words of line 50 lead to the same conclusion?—The electric light circuit is there evidently the electric light circuit of which he has been speaking, and that is emphasised by the words being put between marks of quotation. So that it becomes evident that the electric light circuit is to be a coil for the purpose of magnetising the machine and that the current which passes through the circuit was afterwards passed through the carbons of the lamp.

Going back to line 30, he says, "There are several well-known ways of doing this." What were the well-known ways of doing this at that time?—There was the simple shunt arrangement disclosed by Sir Charles Wheatstone. Then, taking the words "part of the electricity," to mean part of the electric energy, there would be the series arrangement also.

Taking "electricity" to mean only the electric current would exclude the series arrangement?—No doubt it would.

He goes on to say: "The method I prefer is to wrap the soft iron magnets with two insulated wires, one having a larger resistance than the other, &c." Was that a new method so far as you know?—It was.

It has been suggested that the method which he proceeds to describe was really a method for separate excitation. Can you take that view of it?—No, certainly not. In this specification he is describing a particular machine and he does not tell you, except in the paragraphs to which I have referred, how you can wind the magnets of this machine. The method which he is describing must therefore be applicable to the machine which he has described in the body of the specification. Referring to the machine I find he there describes perfectly clearly the way in which the sections of the armature are to be arranged, how they are to be connected together, how they are to be connected with the commutator and how the several segments of the commutator are to be connected with each other.

Is there anything in this, [a specimen of Varley's machine in Court] that is at all consistent with the plan of separate excitation?—In itself there is not. There is no provision there for a separate commutator for taking away the current from a certain portion of the machine.

Shown model 37, witness said it was one of a partly completed series shunt machine. No. 38 was a similar model, with the exception that the armature bobbins were wanting.

HIS LORDSHIP: What is the use of putting in these models?

MR. MURRAY: I shall prove afterwards that these were made by inexperienced persons who simply followed Varley's patent.

Cross-examined by the DEAN OF FACULTY.

Varley invented series-shunt machine?—I have no doubt. He describes it here. In respect of the winding the machine which Haddan described was substantially the same as that of Varley.

I suppose, therefore, you do not dispute that the series-shunt arrangement was a marked improvement upon any arrangements hitherto in use?—It was hardly an improvement for the purpose disclosed by Haddan. It was an improvement no doubt for the particular purposes Varley had in view. It only became a marked improvement by the subsequent discovery of the incandescent lamp.

The series machine was open to objection, was it not, as tending to diminish the magnetism when resistance was increased?—Yes.

And the shunt machine again was exposed to objection as having too much pressure in one way and too little in another?—That was hardly an objection at the time. For purposes subsequently discovered it became a desideratum to have constant potential.

The series-shunt machine had this result, hadn't it, as compared with previous machines, that it combined the steadiness of the shunt machine and the accumulative force of the series machine?—I am afraid I cannot quite follow that.

I mean as regards the exciting of magnetism in the magnets. Didn't the series-shunt machine combine the steadiness of excitation which the shunt gave and the accumulative excitation which the series gave?—Compared with the shunt machine the advantage was really this: When incandescent lamps were introduced it became essential they should be worked at definite pressures. With the ordinary shunt machines of inferior construction, as the current increased the pressure would diminish, running the machine at the same speed. By using the series wound as well as the shunt, you were enabled to keep up the magnetism at one pressure.

And in that sense the series-shunt was a better arrangement than either the shunt or the series machine?—For that particular purpose, undoubtedly.

HIS LORDSHIP: As I understand, it was at the time no great improvement, but, in consequence of the discovery of the incandescent lamp, it became a very great improvement?—Quite so.

THE DEAN: It gave a means of accomplishing an improved result, which means had not existed before?—I demur to its not having existed before.

Apart from Varley's machines it had not existed before?—Yes.

Questioned as to Haddan's patent witness said that he gave no information as to how to make the series-shunt machine so as to give a constant pressure. He did not give directions as to speed nor as to the proportions of the different windings. If the machine were made no doubt it would give a constant potential at a certain speed.

Would not any proportion of the windings give substantially constant potential at some particular speed?—That I can hardly say, off-hand.

Would almost any proportion give substantially constant potential at some particular speed?—Many machines; no doubt, almost.

HIS LORDSHIP: It seems terribly hypothetical—almost any proportion and almost any speed.

Could not the workman, with almost any proportion of coil, reach constant potential by simply regulating the speed?—In many cases he could, no doubt. A machine might be so constructed that at some speed it would give a constant potential, and that speed no doubt he could determine by experiment.

HIS LORDSHIP: I understand that a workman in experimenting on the different proportions of the coil and the different speeds, to find out a thing which would result in approximate potential, would be finding out for himself, and not for Brush's patent?—That is so.

THE DEAN: You desiderate information as to the speed required and the proportions of coils. Could you tell anyone, now, how to give constant potential in any particular machine without knowing all the circumstances of the particular case?—You mean as regards dimensions, the speed of the machine, and so on?

Without knowing the whole circumstances of each particular case, could you give general directions which would secure constant potential in every case?—No doubt you could give general directions but they would have to include the speed and the dimensions.

The workmen in short, according to the requirements of each particular case would even now have to vary the speed and the proportions?—No. Now the thing would be calculable before hand with a very fair degree of approximation, even if he did not know anything of the machine before. If he had experimented on the machine before he could tell with a great degree of approximation.

Did not Brush actually supply dynamo machines with substantially constant potential as early as 1879?—I have never heard that.

Have you seen the Brush machine in court?—Yes.

That is a machine which gives substantially constant potential?—That I could not say; I should require to work the machine to know.

You were engaged, were you not, as a witness for the Messrs. Crompton in their recent suit against the Brush Company, and you made various affidavits in the course of that suit?—I made one or two; I know I made one.

And in these affidavits you went over the various points of objection to the Brush machine, Haddan patent?—I went over some of them.

I suppose you did not willingly omit any objection which you thought was a good one?—In making the affidavit I simply put forward sufficient to make a *prima facie* case.

Are we to understand you kept back any objections which you thought good objections at the time?—No doubt I should tell the solicitors in the case as to whether I should put them in the affidavit or not.

Are you prepared to say you held back any objection which you thought a good objection?—I have not the least doubt I knew objections to the patent beyond those put forward in the affidavit which I made.

Did you report to the Messrs. Crompton after you had examined the patent as to the objections to which it was exposed?—Yes.

Did you keep back in your report any of the objections?

MR. MURRAY demurred to this line of cross-examination.

HIS LORDSHIP: It is to test the gentleman's honesty.

WITNESS (replying): Not that I am aware of. Probably not any I knew of at that time.

You have mentioned to-day various points upon the Brush commutator. Was any one of those points taken in the pleadings in Messrs. Crompton's action?

MR. MURRAY objected.

HIS LORDSHIP: We can't take the pleadings from this gentleman. You must put the pleadings in, if you have got them.

Cross-examination continuing as to the witness's connection with the Crompton action.

MR. MURRAY again objected.

HIS LORDSHIP remarked that no objection need be made. So far as Dr. Hopkinson had gone there was nothing in his evidence which had impressed his lordship adversely.

THE DEAN: Did you, in any of your affidavits refer to any of these objections as regards the commutator?—Not to my recollection.

Why?—Because I did not consider it necessary for the purpose I had in view, or possibly because the solicitors did not consider it necessary.

Did the solicitors tell you not to include them, or did you yourself prefer not to include them?—That I cannot remember.

Didn't they appear to you to strengthen your case against the patent?—So far as I remember my affidavit was made in reply to an affidavit made on the other side.

HIS LORDSHIP: I don't think this is a matter I can go into.

Look at the first sentence of the specification. Do you say that the sentence does not generally describe Brush's commutator as it now stands?—Hardly. With the exception of the segments that would be a description of any commutator, or almost any commutator in use to this day.

Your objection to that passage as a general description is that it is too general?—Too general, no doubt; it doesn't give you the specific features of the commutator in any way whatever.

You first said it did not cover the peculiar screw described?—Yes.

Is not the screw simply a mode of detachably attaching the wearing segments?—Yes, and I am surprised to find it is made matter of specific claim.

Besides the collar in the Manchester commutator you have washers insulating other parts?—Yes; they are introduced there to give greater steadiness.

Does not Haddan's patent state that the collar insulates the whole commutator?—Yes.

When Varley in his specification says, "There are several well-known ways of doing this. But I prefer," doesn't that rather suggest that he considered his method simply one of several well-known ways?—Not at all.

HIS LORDSHIP: Isn't it the case that the mode which he preferred was the compound mode of working which at that time was not known?—That is so.

THE DEAN then cross-examined at length on the text of Varley's specification.

Have you a high opinion of Varley's machine as a whole?—It was not a bad machine at that time, though at present it would not have a chance of living.

Is it possible to store magnetism?—You can accumulate magnetism.

Can you store magnetism for the purpose of converting it into electricity?—No, certainly not.

Isn't that the purpose of Varley?—I say it was another.

Just look at page 7. "My improvement consists in separating the development of the electrical and magnetic forces to a considerable extent." Is such separation electrically possible?—I think in this sense you could get it.

In what case?—In the case of Varley's machine. You get the magnetism passing through the armature at a time when it is cut out of circuit.

"And obtain thereby greater increased magnetic potential in the bobbins?"—I have no doubt he did.

"Which at a later stage becomes converted into electricity of a correspondingly high potential."

Was that possible?—No, certainly not.

Is not Varley's specification mainly occupied in describing a machine which was intended to carry out that improvement?—That might have been his idea. The purpose of his invention was to make a machine which would give greater electric effect, and this machine would have that effect.

In re-examination, witness was shown a photograph of a sketch in Mr. Varley's note-book, and said it indicated a series-shunt action.

Mr. Varley was next examined, and his evidence will be given in our next issue.

(To be continued.)

What is it?—We have heard complaints that the prospectus of the Mining and General Electric Lamp Company, Limited, does not make it clear whether the miners' lamp is supplied with current from a primary or secondary battery. We believe, as a matter of fact, that it is a secondary battery.

NOTES.

The Electric Light in Portsmouth Dockyard.—A scheme was recently under the consideration of the Admiralty for the lighting of Portsmouth Dockyard throughout with the electric light after Ferranti's system. It was suggested to their Lordships that the central pumping station, with its immense resources of superfluous energy, might well be used to generate the electricity. The officials of the yard having, however, reported that in their opinion there would not always be sufficient spare power at the pumping station to keep the numerous lamps which would be required properly fed, the proposal has, it is understood, been abandoned for the present.

Electric Light Poles at Bournemouth.—Permission has been granted the Anglo-American Brush Electric Light Corporation to place stays inside the public pleasure gardens at Bournemouth to support the poles to be erected in the adjoining footpath.

St. Olave's and the Electric Light.—At a meeting of the St. Olave's Board of Works last week, upon the recommendation of the Works and Finance Committee, it was resolved to object to the proposed license of the London Electric Supply Corporation to erect and maintain electric lines and works, and to supply electricity within the district.

Electric Light in the British Museum.—A writer in the *County Gentleman* says, "I could never see why the British Museum should not be open in the evening. The trustees of the National Gallery are perhaps justified in closing their doors at dusk. It would not do to run even the faintest risk of injury to any of the pictures in that priceless collection. But with the British Museum the case is different. I believe the risk would be infinitesimal, even if gas were used as an illuminant. By the use of electricity the danger would totally disappear. Mr. Labouchere, who got an important pledge from Mr. Smith the other night in the House of Commons in favour of opening the Museum, estimates the initial expenditure for an installation of the electric light at the moderate sum of 12,000. Even cheese-paring radicals should not object to so small an outlay. Here is a chance for electioneering, agents on either side. "The Museum for the million!" would not be a bad cry.

A Pearl beyond Price.—The Madras Board of Revenue, it is stated, is sending Dr. Thurston to look about among the European electrical establishments for a globe light to shine twenty fathoms down. By that means the pearl fishers will get to work in deeper water than heretofore.

Electric Light and Fire.—About eight o'clock on Monday night the *employés* in the various departments of the extensive building occupied by the Glasgow Post Office were surprised to find all the electric lights suddenly go out. Soon the report spread that a fire was seen on the roof. The clerks ran out the hose, and were doing their best to extinguish the flames when the brigade arrived, and in a few minutes the outbreak was got under. The fire was caused, it is said, by some defect in connection with the electric lighting apparatus. Later on the building was lighted with candles.

The Anglo-American Brush Electric Light Corporation.—This corporation has just booked an important order from the Pacific Steamship Company for several plants of combined engines and dynamos specially designed for use on board ship. The company is also exceedingly busy with general orders. It has just been awarded a gold medal for its electric fountain display at the Barcelona Exhibition, and a diploma of honour for electric lighting at Brussels.

The Electric Light in Westminster.—At a meeting of the St. Margaret's and St. John's Vestry, Westminster, on Wednesday last week, the Parliamentary Committee reported that it had considered the reference on the question of the desirability of the vestry applying for a licence or Provisional Order for the lighting of the parish by electricity; but, having regard to circumstances generally, did not think it would be expedient for the vestry to do so at the present time. Mr. William Horn, in moving the adoption of the report, said that, as far as his observation went, electric lighting was a failure. A long discussion ensued, and the following resolution was eventually agreed to on the motion of Mr. C. A. Lough, seconded by Colonel Stirling: "That the recommendation now submitted be referred back to the Parliamentary Committee, with power to fully enquire into the whole question of electric lighting, and with authority to enquire of the lighting corporations of London and the provinces, the committee to have leave also to inspect the works of any of the companies in or near London, formed for the purpose of supplying the light."

Newington and the Electric Light.—At a meeting of the Newington Vestry on Wednesday last week, an application was made by the House-to-House Electric Light Supply Company for permission to apply to the Board of Trade for a Provisional Order to light the district. Consent, it may be mentioned, has already been given for the application for Provisional Orders by three other companies. The letter was referred to the General Purposes Committee.

St. James's and the Electric Light.—At a special meeting of the St. James's Vestry on Thursday last week, it was decided, at the instance of Mr. William Jenkins, to consent to the application by the Metropolitan Electric Supply Company, Limited, to the Board of Trade for a Provisional Order to supply electricity in the parish. An application by the House-to-House Electric Supply Company was referred to committee.

The Electric Light and Paris Theatres.—At the last sitting of the Paris Municipal Council, after the dispatch of the routine business, the question of the security of the Parisian theatres from fire came on for discussion. This arose on the proposition of M. Deville acting on a petition of M. Tabourin asking for authorisation to make experiments which would allow of the immediate installation of the electric light. M. Benon then read a report on the measures taken in theatres against fire. While this gentleman was speaking, however, so little attention was paid to his remarks, that he left the tribune protesting. Attention having been again gained, M. Benon went on reading his report, from which it appeared that all the measures had been taken in Parisian theatres with the exception of those which were subsidised, in which much remained to be done.

Lighting of Works.—The new works and foundry of Messrs. John Barker & Sons, Oldham, is to be lighted by electricity. The Lever system of arc lighting is the one they have selected, and the order has been placed in the hands of Mr. Charles Lever, of Bowdon.

Chelsea Electricity Supply Company.—We have received a copy of a memorial addressed by this company to the Chelsea Vestry, protesting against the London Electric Supply Corporation being allowed a wayleave to place its mains under Pavilion Road, which traverses the centre of the district in which the Chelsea Company is now at work laying mains under its Provisional Order. It would be interesting to have it decided whether the vestry has power to grant wayleaves for such purposes in a district for which a Provisional Order has been granted.

The Telephone in Derby.—The National Telephone Company's exchange at Derby was opened on Monday with, for so important a town as Derby, the surprisingly small number of 20 subscribers. No doubt, however, as the advantages derivable from telephonic communication become known, there will be numerous additions to the list. The formalities in connection with the opening took place at the Lecture Hall, Mr. Alderman Roe, M.P., occupying the chair, and a large number of townspeople being present. Mr. Alfred Coleman, general manager of the company, delivered an interesting address in which he gave full information as to the working of the exchange. The chairman afterwards formally declared the exchange open, and wished it every success. The company afterwards had the pleasure of hearing musical performances taking place in Birmingham, Sheffield, and Nottingham. The local agent of the company is Mr. Wm. Hart, and the district manager is Mr. Alfred L. E. Drummond.

A Submarine Telephone Line.—For the last week or two the first submarine telephonic cable has been in working order between Buenos Ayres and Monte Video. The cable runs the length of the bay that separates the Argentine Republic from Uruguay; and, according to the intelligence to hand, it is performing its functions better than the terrestrial telephones in that quarter of the world.

A Self Winding Up Company.—"It is not remarkable, therefore, that the results for the year are unsatisfactory." So states the report of the Self-winding and Synchronising Clock Company, Limited. "The business," we are further told, has "been practically at a standstill," and "the clock being little known, and the company for such a long period having been practically in a state of stagnation, only a small amount of business has been done." Now this, says *Money*, is certainly a frank and candid way of drawing up a report, but it does not say much for the energy and enterprise of those who have the conduct of affairs. Neither does it afford adequate reason why a debit of £4,838 from profit and loss account should be taken as an asset. The total assets are put down at £28,583, out of which only £569 represents cash in hand and at bankers. The remainder of this sum is made up of purely fictitious or imaginary items, such as £20,500 for "patent rights!" After deducting the loss brought forward from profit and loss account—viz., £2,198 to 30th June, 1887, bad debt incurred in 1887 £202, and balance of account on the wrong side to 30th June, 1888, making a total of £4,838—there only remains about £2,500 as being the value of all the other assets. Of these, book debts are taken at £194, but judging by the experience of 1887 this sum may have to be regarded as a loss at the next stock-taking. Really, the Self-winding and Synchronising Clock Company seems to be in a very parlous way.

Catalogue.—Messrs. Drake and Gorham's catalogue takes the form of a number of detached sheets, some giving illustrations, descriptions, and prices of the firm's patent ring contact switches, whilst others are devoted to a patent excess indicator for use with accumulators, standard switchboards, and other specialties. A price-list of accumulators, for which the firm is chiefly noted, of course finds a place, and a list is also given of the installations supplied with accumulators by Messrs. Drake and Gorham.

An Edison Exhibit for Paris.—The *New York Electrical Review* states that Mr. W. J. Hammer, who made quite a success of the Edison exhibit at the Cincinnati Exposition, will soon go to Paris to take charge of a similar exhibit for the great exposition to be held in that city next year. There will be exhibited a specimen of every one of Mr. Edison's inventions.

The Pacific Cable Conference.—We notice in a contemporary an expression of regret that the recent Pacific Cable Conference did not assume the character of a technical debate. The project has, however, got a step beyond this stage, and the only reason for touching on such ground was the necessity of correcting the false impressions which might have remained on the minds of those present had they taken as accurate the information contained in a paper on this subject which had been widely circulated by the Eastern Extension, Australasia and China Telegraph Company. In this circular the usual feeble arguments were again brought forward; the usual plaintive appeal of the "pioneers" was made, and the "unknown depths terminating in coral reefs" did duty once more. The object of the meeting was, as the chairman clearly pointed out, "to obtain an independent expression of opinion from them, as commercial men, whether or not the time had arrived when something should be done to improve the telegraphic communication between this country and the Colonies of Australasia." The presence during the busiest part of the day of those mentioned below (apart from the fact that the resolution was carried unanimously), is a sufficient indication that there is a widespread desire for an improvement in the existing unsatisfactory state of affairs. Among those present were:—The Earl of Winchelsea (in the chair), the Earl of Milltown, Sir Donald Smith, Sir J. P. Corry, Bart., M.P., Sir Chas. Crauford, Sir E. W. Stafford, Admiral Mayne, M.P., Mr. A. J. Mundella, M.P., Capt. E. Palliser, Mr. E. J. Thomas, (Secretary to the Premier of Victoria), Mr. J. Y. Buchanan, F.R.S., Mr. W. Westgarth, Mr. J. McEwan, Mr. W. Blyth, Mr. W. O. Gilchrist, Mr. J. Macfarlane. The following companies were represented:—The Canadian Pacific Railway Company, Dalgety & Co. (Messrs. T. Ducroz, E. Doxat, and A. R. Blackwood), Sanderson and Murray, McIlwraith, McEacharn & Co., A. Sclanders and Co., Harrold Bros., Redfern Alexander, R. Goldsborough and Co., Theo. H. Davies & Co., Henry Brooks & Co., Richardson Bros. & Co., Orient SS. Co., Greenock SS. Co., British India S. N. Co., S. G. Anderson, Messageries Maritimes SS. Co., G. Thompson & Co., Houlder Bros. & Co., Chas. Clark & Co., Great Northern Telegraph Co. **Banks.**—Bank of Victoria, City of Melbourne Bank, Queensland National, New Oriental, Commercial Bank of Australia, Bank of South Australia, Bank of New South Wales, Union Bank of Australia, Bank of Montreal, National Bank of New Zealand, Federal Bank of Australia, Australian Mortgage Land and Finance Co., New Zealand Loan and Mercantile Agency Co., Queensland Land, Mortgage, and Trust, Colonial Land and Loan Co., Freehold Investment Bank of Australia, Land Company of Australia, London and Colonial Finance Co., and West Australian Land Co. Several mining companies were also represented, and many influential gentlemen connected with the colonies were present. It is evident that a meeting thus composed could not have been called together except for the consideration of a matter of urgent importance.

The Value of a Check.—According to *Money*, the promoters of the Electric Register and Safety Check Company, Limited, are not likely to be charged with over modesty. They ask for a capital of £100,000 in shares of £2 each, of which £70,000 is to be paid for the patents—£63,000 in shares, and £7,000 in cash. Intending investors would do well to make careful enquiry before applying for shares. In particular they should ascertain whether it is the fact, as we have been informed, that the patentees of the inventions sold his rights for £1,000 down, and one-fourth of the prospective net profits on their working. The inventions are, we are told, very ingenious, and are in their way commercially valuable; but what might be cheap at four or five thousand pounds would probably be very dear at seventy thousand.

Our Columns.—We are compelled to leave over several interesting letters this week owing to the pressure on our space.

Motor Discussions.—Mr. Albion T. Snell requests us to point out that it was in the *Electrician* of August 31st last that his paper appeared to which Mr. Sprague sent the Answer which we published last week as the copy of a communication sent to our esteemed contemporary. Mr. Snell appears to think that the matter under discussion cannot be clear to our readers, inasmuch as the text of his paper had not the privilege of appearing in our columns; we, on the other hand, think Mr. Sprague's reply so lucid that to gain a correct appreciation of the subject at issue it is not necessary to go back to the origin of the controversy.

A New French Electrical Submarine Vessel.—A correspondent writing from Toulon says:—The preliminary trials of the *Gymnote* have just finished in Toulon Roads. The object of these trials was to allow the designer of the vessel, a retired Director of Naval Construction, M. Zédé, to see whether all his anticipations would prove correct or not, and in the result he was fully satisfied. The vessel becomes submerged like a fish, and can be easily kept at any wished-for depth; it can attain a speed of nine to ten knots; the lighting is excellent, respiration easy, and, in a word, the boat is a great success. Though the normal crew is only three men, there were five on board during these experiments: M. Zédé, M. Krebs, of the Engineers, who designed and constructed the whole of the electrical portion; M. Romazzotti, the naval engineer who built the *Gymnote*, and who introduced numerous improvements in the interior installations; Lieutenant Baudry de Lacantinerie, who is to be the commander of the *Gymnote*, and who manœuvred with courage and precision this extraordinary vessel; and head boatswain Picon, who had been in charge during the construction of the boat at Mourillon. Before being placed with the fleet there are a few inconsiderable interior alterations to be made, such as perfecting in a few points the insulation of the accumulators, which will take about a month, when the *Gymnote* will be ready for service.

Metropolitan Electric Supply Company.—This company is about to apply to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, for authority to produce, store, supply, sell, and distribute electricity for public and private purposes, as defined by those statutes, within the City of London, Westminster, St. George, Hanover Square, St. Giles-in-the-Fields, St. George, Bloomsbury, St. Andrew, Holborn, St. George the Martyr, St. Sepulchre, Saffron Hill, Hatton Garden, St. Anne, Soho, Covent Garden, the Savoy, Strand, and other adjacent places in mid-London.

The Proposed Electric Tramway at Bournemouth.—This scheme, which was being promoted by Messrs. Haynes Bros., who are making great efforts to develop electrical locomotion in the south, has received its quietus. At the last meeting of the Bournemouth Commissioners, Mr. J. C. St. Aubyn Angrove, solicitor, wrote asking that body to accord the necessary permission for the laying of the rails in certain roads under their jurisdiction. On the recommendation of the roads committee, it was unanimously decided to withhold consent.

Electro-Medical Apparatus.—Messrs. Gent & Co., of Leicester, have issued a new catalogue of galvanic, Faradaic, galvano-cautery, measuring, and other instruments used in the practice of electro-therapeutics. It is intended to serve the purpose of a guide for the medical practitioner, the student and the general public in the selection of such electro-medical apparatus as will be exactly suited to their special requirements; and as the descriptions and directions are fully illustrated by well executed woodcuts, anyone interested in these matters could not do better than apply for a copy.

Yorkshire College, Leeds.—In the 14th annual report just issued, special mention is made of the admission of the college to the Victoria University, which took place on the 3rd November, 1887. The University now comprises the three colleges at Manchester, Liverpool and Leeds, and the mere names of these important centres of industrial and social activity are quite sufficient to guarantee the success of an institution which they have united to found.

American Steam Engineering.—Messrs. Sampson Low, Marston & Co. have just published a new and valuable book on steam engineering, entitled, "The American steam engineer, theoretical and practical, with examples of the latest and most approved American practice in the design and construction of steam engines and boilers of every description, for the use of engineers, machinists, boiler-makers, and students," by Emery Edwards, M.E., illustrated with 77 engravings.

Electric Lighting Apparatus.—The fourth edition is just issued of the Electric Apparatus Company's list of machinery and material. In the new issue all obsolete goods have been eliminated, and only those are given which are of the latest and most approved kinds. The Stockport gas engine, now so much preferred for electric lighting purposes, is thus spoken of:—"Having tried this engine on several of our own installations, we can recommend it as being well suited for electric lighting, as owing to its firing alternately at both back and front of the cylinder, increased power and steady running is ensured."

Personal.—We are informed that Mr. George Herbert Little, who is well-known to many of our readers, has been appointed editor of the *Liverpool Journal of Commerce*. Mr. Little has had a successful career in the merchant service, and enjoys the distinction of being the only officer in the mercantile marine who has successfully passed the examinations at the Royal Naval College, Greenwich. He holds certificates for hydrography, practical physics, marine engineering, and naval architecture, in addition to the Board of Trade certificate as master mariner. Mr. Little was for some time in the service of the Eastern Extension Telegraph Company, and afterwards as chief officer in the I. R. G. P. Telegraph Works Company; leaving them, he was for some time in charge of a petroleum-carrying steamer. He then joined Messrs. Woodhouse and Rawson's employ as electrical engineer. He is known to many people as being the inventor of a method for connecting lightships with the shore, which, however, has not been practically tested. We wish him every success in his new avocation.

Mr. Ernest G. Pink, A.S.T.E. & E., informs us that he is leaving the Brush Corporation, after over seven years' service, to join Mr. Cassels, their Argentine agent, first going to La Plata to take charge of the lighting station there.

Conversazione.—The annual *conversazione* of the Glasgow employees of the National Telephone Company was held on Friday last in St. Andrew's Halls. There was a large attendance. During an interval in the dancing, Mr. W. A. Smith, who presided, in a short address referred to the progress made by the company during the past year, and also to the advance made in the Glasgow district. The company's exchanges, he said, had in the year increased from 190 to 221, and the subscribers from 8,800 to upwards of 11,000. The calls that pass through the company's system now amount to over 32,000,000 per annum, while in the Glasgow district alone they reach almost 5,000,000 per annum. The average cost of these conversations to the subscribers is a fraction under a penny. Dancing was afterwards resumed and kept up, with brief intervals, till an early hour this morning. The *conversazione* was enjoyed by all present.

Proposed Signal Station at the Bell Rock.—At a meeting of the Scottish Shipmasters' Association in Dundee last week, it was unanimously resolved to urge upon Lloyd's the desirableness of making the Bell Rock a signal station for passing vessels, by connecting the tower with the mainland by telegraph.

Removal.—We are informed that the Globe Electrical and Engineering Company has moved its stores and laboratory department to larger and more convenient premises at Nos. 2, 4, 6 and 8, Carteret Street, Westminster, opposite its offices.

Electric Railway Signals.—M. de Freycinet, the French Minister of War, is preparing a project for the definite unification of optic, electric, and acoustic signals for the French railway companies. This measure, which has been generally demanded, will be carried into effect as soon as possible.

Smoking Concert.—A smoking concert took place at the Great Eastern Hotel, Limehouse, on Monday evening, under the auspices of the E.P.S. Cricket Club, when some really good music and songs were listened to by a full audience who thoroughly enjoyed themselves. Mr. J. Irving Courtenay took the chair on behalf of Sir Daniel Cooper, who had hoped to preside.

Insulation Resistance.—In specifications for submarine telegraph cables, the *Insulation Resistance* of the dielectric or insulator is always a matter of the greatest importance, and if any portion of the core falls below the specified limit it is rejected. Usually for gutta-percha core it is stated that the insulation resistance of the core shall not be less than 300 megohms per knot at 75° Fah., 14 days after manufacture, and after two minute's electrification. In electric lighting and transmission of power installations, there is a great diversity of opinion amongst consulting electricians and contractors as to what the insulation resistance should be. In fact, no universally recognised standard at present exists in this or any other country. In our last week's issue we published a translation of a communication by M. Picou to the Société Internationale des Electriciens on this subject, which is worthy of attention by our electric lighting friends; and in our correspondence columns of this week we publish a letter by Prof. Jamieson, of The Glasgow and West of Scotland Technical College, giving his own rules and experiences. This subject should be taken up by the Society of Telegraph Engineers and Electricians and thoroughly discussed, so that some definite standard may be arrived at. The circumstances which govern a reasonably good insulation resistance in connection with electric lighting are, of course, very different from those in a submarine cable, or even in a land telegraph line; yet it cannot be gainsaid that many failures have taken place, and much disappointment has been created, by not attending to the thorough insulation of dynamos, motors, leading wires and switches, &c. The rules issued by the Society of Telegraph Engineers, the Phoenix and the Westminster Fire Offices, as well as Jamieson and Picou's rules, are all different. Which is right, and which are purchasers to demand and contractors to follow? We are afraid that in too many instances the insulation resistance is an unknown quantity, or x term, in connection with electric lighting and transmission of power by electricity.

The Graphophone.—At next Wednesday's meeting of the Society of Arts, Mr. W. H. Preece in the chair, a paper on the "Graphophone" will be read by Mr. H. Edmunds.

The "Great Eastern."—This vessel, which is in process of breaking up, was sold some months ago for £16,000. At an auction last week the amount realised for the hull and fittings was nearly four times the above sum.

The Underground Railway.—The *Electrical Engineer* last week contained the following:—"We are glad to hear that satisfactory progress is being made towards the construction of the electric locomotive for the Metropolitan Railway. Many misleading statements having appeared, it may be as well to state briefly what, as we understand, is really proposed by the Electric Traction Company, who have the matter in hand. The Metropolitan directors stipulate that the 'electromotive' shall do their work as efficiently and under precisely similar conditions as the steam locomotives, and without any disturbance of the line or the traffic. This precludes the use of the direct current in any experiment, and necessitates the employment of an independent locomotive with tender, carrying its own power in accumulators simply for the purpose of proving that sufficient power can be exerted by the electromotive. It is only intended to be an experimental demonstration, the electromotive being specially constructed to be used eventually with the direct current. For obvious reasons, it has never been contemplated to use accumulators in any permanent system of practical working. The motors on the engine are being constructed by Messrs. Immisch & Co."

Killed by an Electric Shock.—The *Corriere della Sera*, of Milan, dated 12th November, reports a fatal accident to a workman named Bertola, who was employed by the Edison Company at their central station in Milan. Bertola was in charge of an installation at the Theatre Dal Verme, in Milan. The theatre is some distance from the station, and Zipernowski transformers are employed in the installation. The deceased entered the room containing the controlling apparatus, and was at once seen to fall. Attendance was at hand, and a doctor was immediately summoned; but instantaneous death had resulted from a shock received on his accidentally touching, as is supposed, an insulated portion of the circuit.

Maxim-Weston Electric Company.—The directors of the Maxim-Weston Electric Company have issued a circular to their shareholders announcing that the new issue of shares has not met with a sufficient response to enable them to go to allotment. A reconstruction is to be brought about, by which shareholders may exchange their holding for an equal number of shares in the new undertaking. A feature in the new company is that the directors and their supporters will be the largest shareholders.

Obituary.—The death is announced of M. Rampont, one of the quaestors in the French Senate and formerly Director-General of the Post and Telegraph Department.

The London Chamber of Commerce.—The following subjects have been proposed for immediate discussion by the Electrical Trades' Section:—1, Uniform method of charge by undertakers. 2, Patents, infringement of, &c. 3, Overhead wires regulations. 4, Relations existing between the Trade and Electric Lighting Act. 5, Board of Trade regulations and accounts. 6, Agreement between electric lighting firms and insurance companies and between the firms themselves, to determine the fundamental requirements in all cases and to avoid favouring. 7, Board of Trade regulations as to testing mains and meters. 8, Proper inspection of work on electric lighting installation in connection with fire risks. 9, Tramway Act. 10, Recognition of electrical standards. 11, Removal of vested interests. 12, Reports on exports, markets, Customs duties, railway rates, and share quotations. 13, Fire Insurance rules. 14, Standard specifications. 15, Uniformity of incandescent lampheads. 16, Uniformity of screws in instruments. 17, Relations between supply companies and local bodies. Here is enough and to spare for consideration; but are not some of the suggestions rather without the province of this newly-formed body? What think our readers?

Electrical Storm at Sea.—The Guion Line steamer *Alaska*, from New York, brought intelligence of the ship *Edward*, from Havre, with a cargo of iron ore, whose captain reported that the vessel encountered a terrible electrical storm in the Atlantic on the night of the 31st ult., when in lat. 41.42 N., long. 54.42 W., lasting for several hours. The vessel was continuously enveloped in lightning, which prostrated on the deck 11 seamen, and deprived them of sight for nearly half a day. The second officer and the boatswain were also dashed to the deck and received serious injury, and the former was speechless for five hours. Three "balls of fire" exploded with a tremendous report over the main rigging, scattering flaming fragments over the ship, and driving the remaining members of the crew in terror into the fore-castle. From 3 a.m. until 7 p.m. the captain and mate were the only persons on board capable of doing any work, and on them devolved the task of keeping the vessel before the easterly gale. The captain states that all on board the ship were trembling with fear during the time that the storm lasted, which was the most terrible he ever witnessed, and he adds that no doubt the iron ore with which the ship was laden acted as a magnet to attract the lightning.

Mill Lighting.—Messrs. Chivers and Sons, of the Home-made Jam Works, established now some years at Histon, in Cambridgeshire, are extending their premises, on which are already employed about 100 hands, and have introduced the electric light. The installation has been carried out by Crompton & Co., Limited, and consists at present of 50 incandescent lamps and two arcs. Ten of the incandescents are of 50 C.P., and the remainder of 16 C.P. The dynamo gives 45 amperes and 110 volts at 1,700 revolutions, and is driven by a new engine just put down for the works.

Execution by Electricity.—The New York Medical-Legal Society have held several meetings lately for the purpose of preparing essays upon the subject of taking life by electricity. These essays have been submitted to a special committee authorised to devise the best methods for carrying out the new law, which provides for the conduct of executions after the 1st of January in the State of New York by the method of electricity. After mature deliberation the following plan has been devised for this new form of execution:—A stout table, covered with rubber cloth, and having holes along its border for binding, or a strong chair, should be procured. The prisoner lying on his back or sitting should be firmly bound upon this table or in the chair. One electrode should be so inserted in the table or into the back of the chair that it would impinge upon the spine between the shoulders. The head should be secured by means of a sort of helmet fastened to the table or back of the chair, and to this helmet the other pole should be joined, so as to press firmly with its end upon the top of the head. The chair is recommended in preference to the table. The rheophores can be led off to a dynamo through the floor or to another room, and the instrument for closing the circuit can be attached to the wall. The electrodes should be of metal, not over one inch in diameter, somewhat oval in shape, and covered with a thick layer of sponge or chamois skin. The poles and the skin and the hair at the points of contact should be thoroughly wet with warm water. The hair should be cut short. A dynamo generating an electromotive force of at least 3,000 volts should be employed. Either a continuous or alternating current may be used, but preferably the latter. The current should be allowed to pass for 30 seconds.

NEW COMPANIES REGISTERED.

Mining and General Electric Lamp Company, Limited.—Capital: £100,000 in £1 shares. Objects: To adopt an agreement of 24th November, entered into with the New Portable Electric Lamp and Power

Syndicate, Limited, and to acquire any inventions for producing, supplying, or using electricity or electrical currents and force. Signatories (with 1 share each): F. H. Sumner, 17, Queen Anne's Gate, S.W.; B. Nicholson, South Norwood Park; J. E. Wood, 16, Maltham Grove, East Dulwich; H. W. Roach, 33, Worlingham Road, Goose Green; J. E. Holman, 104, Fort Road, S.E.; G. W. Francis, 38, Kimberley Road, Clapham Rise; H. A. Harrison, 90, Royal Road, Kennington Park. Directors' qualification: 500 shares. The first directors are the Earl of Crawford, F.R.S.; N. Story Maskelyne, F.R.S., M.P.; the Hon. Reginald Brougham; J. Y. Stephen, J.P.; Dr. Frankland, F.R.S., D.C.L.; and Dillwyn Parrish. Remuneration: £2,000 per annum. Registered 24th November by Paine, Son and Pollock, 14, St. Helen's Place.

Windsor and Eton Electric Light Company, Limited.—Capital: £30,000 divided into 5,950 shares of £5 each, and 250 founders' shares of £1 each. Objects: To carry on business as electrical engineers, electricians, engineers and contractors. Signatories (with 1 share each): Major-General C. E. Webber, 17, Egerton Gardens, S.W.; Lord E. S. Churchill, A. W. Shipley, Datchet; A. Shipley, Datchet; A. Fox, Windsor; W. Sevenoakes, Windsor; W. J. McCloskie, Windsor. The signatories are to appoint the first directors. Qualification: 20 shares. The company in general meeting will determine remuneration. Registered 24th November by Sydney Morse, 4, Fenchurch Avenue. Registered office, Acre House, Windsor.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Chelsea Electricity Supply Company, Limited.—An agreement of October 15th between this company and Callender's Bitumen Telegraph and Waterproof Company, Limited, provides for the modification of an agreement of July 9th. Clause 7 of the said agreement is rescinded, and is to be read as if the following words had been omitted from the first clause, that is to say, "and not before the capital of the company has been subscribed." In all other respects the said agreement is confirmed.

Edison and Swan United Electric Light Company, Limited.—The annual return of this company made up to November 13th was filed on the 14th. The nominal capital is £1,000,000, divided into 150,000 "A" and 50,000 "B" shares of £5 each. The shares taken up are as follows:—89,261 "A," £3 paid, 17,139 "A" fully paid, 23,564 "B" fully paid. The calls received amount to £267,783, and the sum of £203,515 is considered as paid upon 40,703 shares.

Bournemouth Electric Light and Power Company, Limited.—At an extraordinary general meeting of this company held at Richmond Chambers, Bournemouth, on July 25th, a resolution was passed authorising the voluntary winding up of the company. Mr. Edward Becker and Mr. F. H. Credland were appointed liquidators. The resolution was duly filed on November 22nd.

The statutory return of the company made up to May 29th was filed on the 22nd inst. The nominal capital is £4,000 in £5 shares. 200 shares have been taken up and the full amount has been called thereon. The calls paid amount to £981 5s., and unpaid to £18 15s.

East Strand and District Electric Light and Power Company, Limited.—The statutory return of this company made up to the 21st inst. was filed 22nd inst. The nominal capital is £5,000 in £5 shares. 7 shares have been taken up and £35 has been paid thereon. Registered office, 222, Strand.

Lancashire and Cheshire Telephone Exchange Company, Limited.—The annual return of this company made up to September 18th was filed on the 20th inst. The nominal capital is £400,000 in £1 shares, the whole of which are taken up and are fully paid.

CITY NOTES, REPORTS, MEETINGS, &c.

Pilsen-Joel and General Electric Light Company,
Limited.

The seventh ordinary general meeting of the shareholders of this company was held at the Cannon Street Hotel last Friday, Sir Rawson W. Rawson, K.C.M.G., C.B., presiding.

The notice convening the meeting having been read,

The Chairman said: Ladies and gentlemen,—This is our annual meeting, and the directors have thought it a suitable opportunity for bringing before you the state of affairs as they exist at present, with a review of what has taken place during the present year since the important meeting in March last, and have thought it desirable to invite an expression of your views and wishes as regards the future operations of the company. We (the directors) expressed our opinion on the subject in March last, but our views did not meet with the support of a sufficiently large body of the shareholders. My colleagues were re-appointed, and we were instructed to make provisions for the sale of the business. I merely briefly review this—it is stated in the report—to bring the matter fresh to your minds. Well, we did do our best to obtain an offer for the business. That offer was brought to your notice, and although it was a small one it was considered that under the circumstances it would be advisable to accept it. However, an obstacle was placed in the way of carrying out that sale, and we brought the matter again before our shareholders. One or more shareholders were at that meeting of opinion that if a little time were allowed an opportunity would present itself of obtaining some satisfactory offer superior to that made by the proposed purchaser. The directors then determined that they would allow until the general meeting for any shareholder to make such a proposal; and none having presented itself as the time approached for this our annual meeting, we prepared a report stating the circumstances, and laying before the shareholders the position in which we are now placed. Our recommendation was not approved—the arrangement that we had proposed in accordance with the expressed wish of the shareholder was not approved, or was stopped and thrown over, and now the time has come for something to be done. I have to say that we have received two communications from shareholders, one of which is from Mr. Rooper, stating that it is his intention at the present meeting to propose steps for the voluntary liquidation of the company. The other is from Mr. Fellowes, who comments in detail on the transactions of the past year, which is not the question exactly which is before us, but who makes no definite proposal; he says that it is the director's business to make a proposal. We have made a proposal: you have not accepted it. We have adopted your wishes: we have not been able to carry them out. We have given the shareholder who thought he could obtain an offer plenty of time—more time than the two months mentioned at the last meeting—to obtain an offer. No offer has been made, and now, as the directors state here in the report, having explained the position, we feel that it rests with the shareholders to furnish an indication of their wishes, and it will be my duty to bring before you the definite proposal sent in by one of your body. But the order of our proceeding is first to propose the adoption of this report and the accounts. The first resolution therefore is:—“That the report of the directors, dated the 10th of November, 1888, together with the accounts and balance sheet for the year ending the 30th of June, 1888, be received and adopted.”

Major Scriven seconded the resolution.

Mr. Hopkins said that in glancing through the accounts and comparing them with those of last year he found that £3,000 worth of Consols had been sold, and that £3,672 had been received in the way of calls. Then the indebtedness on June 30th as compared with the previous June 30th had been increased by £740, making a total of £7,400. He was at a loss to see where the whole of this money had gone. He noticed that a sum of £3,634 had been expended in the purchase of stock and plant for the extension of installations, and £1,307 was put down to general factory charges. In looking through the previous account he saw that this was the first time such an item had appeared, and he would be glad of information as to what it meant. There was a heavy item too for law charges, and he could not understand what they had spent £300 in law for this year.

Mr. Fellowes read a long letter, a copy of one he had sent to the directors, in which he suggested that the latter should prepare some kind of statement, showing what they thought they could do if more capital were forthcoming, and what profits they thought they could make.

Mr. Cuthbert Quilter, M.P., said he was himself a large shareholder in the company and represented others who were also large shareholders. Ever since they had been in the company they had loyally supported whatever directors had been on the board, had paid punctually all the calls made, and had never taken part in any agitation which had been raised. But he now felt it his duty to state that he and his friends did not intend that the company should go on as it had been going on, reducing its money and coming upon them for fresh funds. They did not believe that the company could be successfully carried on, and he was quite sure there must be many shareholders who could ill afford to meet these constant drains upon them for no good purpose whatsoever. Therefore, they had come to the conclusion that if the company be not wound up voluntarily—which, having had some experience of winding up, he thought would be the best for their interests as affording the cheapest and most expeditious way out of a bad

bargain—they would deem it their duty to take such steps as would procure its being wound up compulsorily.

Major Scriven, replying to the remarks of Mr. Hopkins, said they had really called up £3,069 further capital, and had increased their liabilities by £739; there was a decrease of cash on the year, not of £3,000, but of £3,068. In other words, on that side of the account they were £5,871 worse off. But on the other side there was an increase of stock—valued very fairly, and with full allowance for depreciation—£3,805; increase of book debts, £666, one or two other minor items, and £440 paid in dividends since the last balance-sheet.

Mr. Hopkins: Was that all paid out of profits for the year?

Major Scriven replied that there was no doubt as to that. Those figures, taking into consideration the sum carried forward, very nearly balanced. The item of general factory charges had previously been included under another more general heading, but it had now been separated, with the view that the shareholders, if they continued the business, might see what the general annual charges were from year to year. Alluding to Mr. Fellowes' remark that the directors should put forward some definite proposal, Major Scriven said the directors put forward a proposal in March last that they should expend further capital, and write off all their present nominal value, believing that then they would be in a position to make a large profit. They thought that that still might be done, but whether it was advisable to attempt it, in view of the litigation and unpleasantness which might arise, was for the shareholders to determine. They could not give an estimate of probable expenditure and probable profit. They merely had the nucleus of a business. They had increased their rentals by £3,000 since March last, and by obtaining more capital they could increase them still more. But they could not do so if they were going to fight, and if everything was to be disputed.

The resolution for the adoption of the report was put and carried.

Sir Rawson W. Rawson having been re-elected a director of the company, and the auditors, Messrs. Hays, Akers and Hays, having been re-appointed,

The Chairman called upon Mr. Rooper to move the resolution of which he had given notice, to the effect that the directors should be requested to take the necessary steps for voluntarily winding-up the company.

A question arose as to the competency of the meeting to discuss such a resolution, and eventually, Mr. Whately stating that the articles of association would not allow anything but the current business to be transacted without notice having been given, it was decided that it should be put in the form of a recommendation to the directors.

Mr. Rooper, in moving it, said his chief argument was that a house divided against itself could not stand. He was quite sure they would not see a farthing back if the company was compulsorily wound up, and probably they would be called upon for a large proportion of the uncalled capital.

Mr. Quilter having seconded the recommendation,

Mr. Gwynne spoke in support of it, remarking that he had come to the same conclusions as Mr. Quilter and his friends, that if the company were not voluntarily wound up he would take steps to have it wound up compulsorily.

Mr. Hopkins suggested that the directors should state their opinion as to what would be the best policy under the circumstances.

The Chairman said his opinion in March last was that if they had been a united body and their affairs had not been so much damaged by what had occurred, they might have been able, by raising more capital, work at a profit. But they had the most definite expression of opinion from the shareholders that they would not subscribe any more money, and he did not see any chance of carrying on satisfactorily.

Major Scriven also thought if they had raised further capital in March last, they would have been able to work to a profit.

Mr. Whately agreed with these views, but doubted whether Major Scriven's conditions would be carried out. They would find it difficult to get anyone to associate himself with them in reconstructing; those who had money would prefer to buy them and have done with them. His opinion was that the best thing for them to do would be to go into voluntary liquidation.

Mr. Quilter moved a vote of thanks to the directors, and said the shareholders were not likely to get any of their money back by putting more money into a disunited, discredited company. It would be better to form a strong combination outside to purchase, so that those who believed in the future of electricity as a paying concern might be able to show their faith, whilst those who wished to retire from the company might do so.

Mr. Gwynne seconded the motion, which was carried unanimously.

The Chairman briefly replied, and the meeting terminated.

Crompton and Company, Limited.

The first ordinary general meeting of this company was held at the Cannon Street Hotel on Thursday, the Right Hon. Viscount Torrington presiding.

Mr. F. R. Reeves, the secretary, having read the notice convening the meeting,

The Chairman stated that, this being only the statutory meeting, there was but little to add to the statements made in the prospectus, but the directors had been in office long enough to

make themselves fully acquainted with the business, and to satisfy themselves that the company had acquired a valuable property. It would be unwise at a public meeting to give details of the contracts in negotiation or of the orders in hand; it might be stated, however, that orders had been taken for a complete installation of electrical plant sufficient for 2,000 lights for a supply company for a provincial town, and also one for a Continental town, and two large installations of docks, besides a quantity of machinery and plant for the Kensington and Knightsbridge Electric Lighting Company, which company had so well served its customers, there having been no failure of the light since they started, some two years ago, that they had orders coming in faster than they could execute them. It was now a well-ascertained fact that electric lighting could be made to pay, and, indeed, to pay well, if only the supply be to a sufficiently large number of consumers, and as a consequence of this knowledge electric supply companies had been started in many places. Each of these companies would require electrical machinery, plant and fittings, some of the orders for which would almost undoubtedly come to this company. In addition to the employment of electricity for lighting purposes, it was admirably adapted for motive power. Quite recently an electric crane had been constructed at the works for a firm of large London manufacturers. By means of such cranes builders would get rid of the necessity of placing a steam engine at the top of high scaffolding; the power would in future be generated below and carried up to the crane by means of a small wire. The crane in question had been in use for about two months and gave great satisfaction, and further orders for that class of work were expected. Various other negotiations were in progress for central station lighting, but these were not sufficiently advanced to admit of their being confidently announced to the shareholders; the directors, however, were hopeful of being able shortly to report something more definite upon this subject. The Arc Works at Chelmsford were in good order, and with the few additions now being made to them were sufficiently large and complete to meet the additional orders which the increased working capital was expected to bring. The management of the company's business was well placed in the hands of Messrs. Crompton and Albright, two gentlemen who owed their position in the electrical world entirely to their professional skill, integrity, and untiring perseverance. They had shown their confidence in the company by re-investing £25,000 of their purchase money in preference shares, in addition to their £40,000 of ordinary shares, which were paid to them as part of the purchase money. Thus the company had every security that those gentlemen, who were so largely interested in the business, would do their utmost to make it successful. The directors hoped to be able to declare an interim dividend in the month of January, and at the same time proposed to pay the interest to those who had paid up in full on their shares. Mr. Crompton had gone to Vienna to arrange some matters with the Imperial Continental Gas Association, and was at that moment in Berlin, where he hoped to make some important arrangements for the benefit of the company.

After a few questions had been asked and answered as to the manner in which dividends would be paid, a vote of thanks was accorded the chairman, and the meeting terminated.

Blackpool Electric Tramway Company, Limited.

THE fourth ordinary general meeting of this company was held on Saturday at the tram shed offices, Blundell Street, Blackpool. Mr. R. Horsfall (chairman of the company) presided.

The Chairman moved the adoption of the statement of accounts and directors' report. In commenting upon the report, the Chairman said had they taken less for depreciation and so made the dividend five per cent. there would have been a less dividend next year. The working expenses had been reduced this year something like £500. Last year they were £4,291, this year £3,798. On the other hand the receipts last year were £4,406, this year £5,443, showing that whilst there had been economy in the working the traffic had so increased that they had now got into a sound position. The machinery was equal to, if not better than what it was a year ago. The line was in good working order, and he thought there was every prospect of a good future. It might be said this company had gone to great expense in the formation of its plant, and that was true. No doubt material could be obtained at less cost now, for science and other things had developed of late, but he believed Mr. Smith's electric tramway was the best of anything of the kind in existence at the present time.

Mr. Hoyle seconded the resolution, and said as last season was a very good one, he had hoped to have had a larger dividend.

The Chairman explained that as last year only £400 was put to the reserve fund, instead of £700, the amount was made up this year, this being a good season.

The motion was unanimously agreed to.

The Chairman, in referring to the next business, that of the election of directors, suggested that the number be nine instead of ten, as three could then retire annually.

The retiring directors, Messrs. Richard Horsfall, John Bickerstaffe, and Jas. Broadbent were then re-elected.

Mr. Hoyle, in seconding the motion for their re-election, called attention to the Sunday question. He was informed that if they were to run three months in the year on Sundays in the season, they would clear all expenses. Was it not possible to make some arrangements with the town?

The Chairman said he was very glad this question had been raised. In the early part of the season they wrote a letter to the

Corporation of Blackpool offering to give the Corporation £200 if they would let the company run on 13 Sundays. It was considered by the Highway Committee, and finally the consent was refused. He could not understand the action of the Blackpool Corporation, except it was that they were ruled by the cabmen of the town. Visitors had commented on the fact that tumbled disgraceful omnibuses were allowed to run on the promenade, and there were no electric cars.

Mr. Hoyle suggested that a deputation wait upon the Corporation in reference to the matter.

The Chairman: If you got the cold shoulder as we do, you would not be very willing.

The Chairman, Alderman Bickerstaffe, and Mr. Broadbent having responded, Mr. J. D. Taylor was re-elected auditor, and a vote of thanks to the chairman concluded the proceedings.

Monte Video Telephone Company, Limited.—This company announces that the certificates are now ready for delivery in exchange for banker's receipts and letters of allotment.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 23rd, 1888, after deducting the 5th of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,503.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending November 23rd, amounted to £5 843.

NEW PATENTS—1888.

16629. "Improvements in galvanic batteries." F. CRAMER. Dated November 16.

16653. "Improvements in electro-motors." O. FROELY. Dated November 16.

16654. "Reflecting shades for electric lamps." C. M. DORMAN and R. A. SMITH. Dated November 16.

16658. "Improvements in or connected with safety junctions for electric lighting." T. TAYLOR and W. TUNNICLIFFE. Dated November 16.

16681. "Improvements in and relating to multiple telegraphy." F. J. PATTEN. Dated November 16. (Complete.)

16694. "Improvements in electrical instruments for transmitting information." J. H. THOMSON. Dated November 16.

16728. "Improvements in dynamo-electric machines." N. G. THOMPSON. Dated November 17.

16740. "Improvements in the arrangements for working railway signals and points electrically." I. A. TIMMIS. Dated November 17.

16766. "Improvements in electric lamps or lighting apparatus." A. L. SHEPARD. Dated November 19.

16809. "Improvements in voltaic batteries." H. I. HARRIS and J. GARFORD. Dated November 19.

16813. "Improvements in secondary generators or induction transformers." G. C. FRICKER. Dated November 19.

16829. "An improved portable lamp and dynamo combined." R. THOMPSON. Dated November 20.

16852. "Improvements in appliances designed for use in connection with variable electric currents, the said improvements being also applicable to alternate current motors." W. T. GOOLDEN, L. B. ATKINSON and S. C. G. GOLD. Dated November 20.

16855. "A combined electric conductor and interrupter." F. MORRISON. Dated November 20.

16881. "An improved method for utilising gas and electricity for illuminating names of railway stations, shop signs, facias, and trade signs generally." W. SPARROW. Dated November 20.

16900. "Improvements in electrical fusible cut-outs." C. GRIVOLAS. Dated November 21.

16928. "Improvements in brushes and contacts for dynamo-electric generators, motors, and other purposes." R. E. HUTCHINSON. Dated November 21.

16939. "Improvements in the construction of electric bells." G. BINSWANGER and H. J. COATES. Dated November 21.

16946. "Improvements in fittings and switches for incandescent electric lamps." J. Y. JOHNSON. (Communicated by T. Mace, United States.) Dated November 21.

16947. "Improvements in connection with continuous electric current transformers for automatically regulating the current in the working circuit." LAURENCE, PARIS and SCOTT, Limited, and W. H. SCOTT. Dated November 21.

16959. "Improvements in electric contact apparatus to be operated automatically by heat or by hand pressure." C. F. HILKIER. Dated November 21. (Complete.)

17002. "An improved fluid for primary batteries." T. COAD. Dated November 22.

17008. "Improvements in dynamo machines." F. V. SCHLÖDT. Dated November 22. (Complete.)

17013. "Improvements in electric meters or apparatus for measuring electricity." C. WATSON. Dated November 22.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

18386. "Improvements in machinery or apparatus for producing and administering electric shocks and currents." J. DOUGLAS and H. ASBOTT. Dated October 1. 8d. Claims:—1. In a machine for administering electricity for curative and other purposes, the employment of tubular handles which are attached to a crossbar arranged to slide telescopically upon fixed tubes or guides, substantially in the manner described. 2. In a machine adapted to administer an electric current upon the insertion of a coin, token or the like, and having two handles, both of which are movable, the employment of a balanced lever adapted to normally lock both handles and to release the same simultaneously upon the insertion of a coin or the like, substantially as described. 3. The manufacture and use of the improved machine consisting of the parts constructed, and combined substantially as described with reference to the drawing, and operating as and for the purposes set forth.

18608. "Improvements in galvanic batteries." P. SKRIVANOW. Dated November 4. 4d. The inventor forms a battery of two elementary parts, one an attackable electrode, say of iron, tin, or zinc, by preference amalgamated, the other a plate of retort charcoal, agglomerated charcoal, a sheet of lead or other conducting substance which cannot be attacked by the exciting liquid used. Over this conducting plate he spreads a layer say of .04 to .12 of an inch in depth of peroxide of lead, or else minium, and he envelopes the whole in a sheet of parchment paper, or cloth, or asbestos which he retains with India-rubber bands, or by tying threads around it. The two electrodes are placed into a solution of hydrate of potassium K_2HO , or hydrate of soda $NaHO$. By covering the positive electrode with several sheets of filtering paper, or cotton, or asbestos soaked in the above solution and applying above it the negative electrode, a dry battery can be obtained. The claims are 2 in number.

18628. "Improvements in dynamo-electric generators and motors." W. T. GOOLDEN and L. B. ATKINSON. Dated December 2. 8d. Claims:—1. The construction of dynamo-electric generators or motors, having an air-tight, or nearly air-tight, or flame proof, case surrounding the commutator, and in which case the brushes are wholly, or partly, contained, the other parts of the armature being open to the atmosphere. 2. The combination of a commutator placed on the side of the bearing, remote from the armature with a casing containing the brushes and continuous with the bearing, in the manner substantially as described and shown in the drawings. 3. The combination of a commutator with a casing containing the brushes and a packing ring for maintaining an air-tight or flame proof joint at the commutator surface, or its equivalent, in the manner substantially as described and shown in the drawings.

17089. "Improvements in the construction of the cores of the armatures of electromotors and dynamo machines." M. IMMER. Dated December 12. 8d. Claim:—The employment of collars, keyed to an armature spindle, one of which collars is capable of longitudinal movement thereon, while both collars are formed with grooves, the bottoms of which are inclined or tapered, and which grooves receive keys having correspondingly inclined surfaces so that the longitudinal movement of one of the collars will cause the keys to move outwards, and by acting upon the plates or wire of which the armature is built up, will firmly hold and tighten the same, while exerting a yielding or elastic pressure thereon, substantially as specified.

1888.

11408. "Improvements in apparatus for the propulsion of vehicles by electricity." H. H. LAKE. (Communicated from abroad by F. J. WEIS, of America.) Dated August 7. 8d. The object of the invention is to provide improvements, which are applicable to cars driven by an electric motor, irrespective of the source from which the current to operate the motor is supplied and which relate generally to a motor supporting frame carried directly upon the axles of the driving wheels, a main car frame supported upon springs which in their turn are supported upon laterally movable boxes in which the axles of the driving wheel are respectively journaled; a motor for rotating a countershaft provided at one or both ends with a suitable spur or friction wheel or wheels adapted to respectively engage the driving wheels; stationary brakes arranged in the vertical planes of the driving wheels, respectively; manually operative starting and stopping apparatus embracing means for moving the driving wheels at each side of the car toward each other, and thereby bringing them into engagement with the said spur wheel or spur wheels, or for moving the driving wheels away from each other, and thereby disengaging them from the said spur wheel or wheels, and bringing their peripheries into contact with the said stationary brakes. The claims are 5 in number.

11411. "Improvements in armatures for dynamo-electric machines." A. W. MESTON. Dated August 7. 8d. The objects of the invention are:—1. To provide means in flat ring armatures whereby sections thereof, comprising one or more coils, which have become damaged, may be readily replaced by duplicate and perfect sections, and to have such sections of such dimensions and form as

will allow of their being revolved in an ordinary lathe or other suitable machine for the purpose of winding the armature coils, doing away with the slow and laborious method of hand winding which the form of the ordinary ring armatures necessitates. 2. Improvement in the construction of laminated flat ring armatures, whereby, without materially affecting their strength, and without materially increasing the magnetic resistance of the core, sections or portions of the ring having one or more coils wound thereon, can be readily detached and taken out, and duplicate sections inserted. 3. Improvement in the construction of laminated sectional ring armature, whereby interchangeability of parts is attained. 4. To combine with the foregoing features a perfect insulation of the laminas composing such armatures and of the sections from each other without materially affecting the continuity of the core. 5. To combine in a laminated sectional ring armature strength, rigidity and accuracy of structure and cheapness of manufacture. 6. To provide for the ventilation of such armatures; and 7. Improvement in the manner of attaching such armatures to the spiders on which they are mounted, providing at the same time for the insulation of the armature from the spider. The claims are 17 in number.

12395. "Improvements in electro-therapeutic belts." A. J. BOULT. (A communication from H. P. Pratt, of Chicago.) Dated August 28. 8d. Relates to improvements in the class of electro-therapeutic belts which involve as essential features a series of galvanic cells, connected with a girdle for attachment to the person, and having the poles connected by suitable conductors with electrodes to be applied to the body of the wearer. The claims are 13 in number.

12706. "Improvements in storage battery plates." W. P. THOMPSON. (A communication from abroad by C. D. F. GIBSON, of New York.) Dated September 2. 6d. Claims:—1. A storage battery plate consisting of a sheet of metal having transverse openings, a button of the same material extending through each opening, and having an enlarged head at each end, and active material filling the spaces in the openings about the buttons. 2. A storage battery plate consisting of a sheet of metal having openings, buttons placed in each opening, consisting of a central stem and enlarged heads, and active material placed in each opening about the said buttons. 3. A storage battery plate, consisting of a sheet of metal having rectangular openings, buttons of metal extending through each opening, and consisting of central stems and flattened ends of diamond shape, said ends being approximately flush with the respective surfaces of the plate, and active material about the buttons.

12761. "Improvements in dynamo-electric machines." A. G. WATKINSON. Dated September 4. 8d. Relates to the combination with a dynamo machine constructed as described, of a device responding to changes in the main current and mechanism controlled by such responsive device, whereby the resistance of the field circuit, or the shunt circuit, or one relatively to the other, that is to say, the resistance in one decreased while the resistance of the other is increased—may be automatically varied and the more perfect regulation of the machine thereby effected. Further relates to the combination with a machine constructed as described, and with the electro-responsive device, of a supplemental hand resistance which may be employed with or independently of the electro-responsive device, and as supplemental thereto. Also relates to the combination with a machine constructed as described, and with an electro-responsive device adapted to operate as described, of a device responding to changes in the main current whereby a high resistance may be cut into the shunt circuit or the shunt circuit broken, for the purpose set forth. The claims are 14 in number.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this Society was held on Thursday, November 22nd, Mr. E. GRAVES, president, in the chair. The ordinary general business of the meeting having been transacted, a paper on "A System of Electrical Distribution" was read by Mr. HENRY EDMUNDS, member.

It has been remarked that it is undesirable to bring a paper of this kind before a scientific society on a subject which is only in its initial or untried stage. While there may be some justice in this remark, I think that in bringing this paper before this Society to-night I may have the opportunity of laying before you the results of certain experiments and actual work now extending over some 10 or 12 months, and of pointing out to you what have been the results of that work and what the indications are with regard to its usefulness and extension.

In designing this system of central station lighting it has been my endeavour to develop a plan of effectively and economically distributing the electric light over a given area, which should practically isolate each installation and make it independent and self-contained; which should obviate the use of objectionable machinery on the consumer's premises; which should ensure freedom from powerful and dangerous currents of electricity; which should provide a reliable supply of the electric current at all hours of the day or night; and which would enable a simple

and readily understood form of meter to be used that would command the confidence of the consumer.

One of the great desiderata of a system of lighting is constant supply. It is not sufficient to supply the illuminant for a specified number of hours per day. What the householder wishes to have is a means by which he has always at hand a reliable source of light, capable of supplying all his requirements night and day. To ensure this it would be necessary either to have the generating machinery always at work during the whole 24 hours or to employ some system of storage. Even if the machinery were constantly kept running, however, that would not render the constancy of the supply absolutely reliable, for the machinery might break down owing to accident or wear, and the district deprived of light until the necessary repairs were made. Therefore, it is essential that a reserve of electricity, independent of the generating plant, should be at hand, and such a reserve can only be obtained by the use of storage batteries.

The subject of electric lighting in conjunction with storage batteries is one that is receiving considerable attention from a good many engineers at the present time. The desirability of working with them has, I think, been admitted by most engineers for a long period, but the difficulty in connection with their use has been great. Among other things the durability and efficiency of the battery itself has been more or less an unknown quantity, and this has caused people to hesitate before embarking upon any large amount of work dependent on them. It is hardly my province now to go into the history of the several methods which have been tried, but we may simply look on the two broad modes of working, viz., charging batteries in multiple, or charging them in series. As we do not, in this system, propose to charge in multiple, we can leave that out of the question. We may therefore consider the mode that we are here adopting of charging batteries in series. It has been found to be more economical to use comparatively small conductors with suitable current, and high electromotive force enabling one to carry the current over long distances from central stations and to supply the current at different points on the line, as may be required for local work or use.

An opportunity for distributing current over a large area was presented to me some months ago, where a central station was available suitable as to its position and size, but a long way from where it was intended to supply the bulk of their current for lighting purposes. It was necessary for them to consider the respective advantages of direct supply with low tension, and high tension in conjunction with transformers. The former was out of the question on account of the distance; and the latter was at that time in disfavour, owing to several breakdowns and interruptions of the light to consumers having been reported in London. It was therefore deemed desirable to work in conjunction with a reserve, such as storage batteries in some form or other, and the idea occurred to me that a system might be developed which would practically be analogous to the transformer system, but using direct in lieu of alternating currents, and charging batteries in series with a constant current on one main line, rather than in parallel, and simply increasing the E.M.F. as the work increased, and as the length of the line extended. This might be done in several ways. By dividing the line into sections, charging each portion for a good number of hours, according to the probable demand, or by an arrangement for supplying current from the main to a portion of any group of cells less than the whole; but here a difficulty occurs, for it is most undesirable to be charging batteries as a whole or in part at the same time that they might be wanted for discharging. To obviate this, the batteries might be duplicated, so that one portion might be in the charging main and the other in the local. But this again is limited by the number charged in series at the same time. Besides this, the cells that have been charged have a large difference of potential, when brought into the local, which causes a fluctuation of the lights when such changes occur.

This brings us to the system which I have devised. Sets of accumulators are placed in groups at various points or sub-stations throughout the district to be lighted, and charged in sections from the central station. The secondary batteries at such sub-station are divided into four equal groups, with any convenient number in each group. For instance, we may have four sets of eight cells each, of which three sets, or 24 cells, will always be in connection with the lamp circuit, and supplying current locally to those houses which are in connection with the sub-station, while the fourth section will be in the main circuit in series with the other sub-sections, being charged by the current from the central station. At short intervals the charged group is switched out of the main circuit into the supply, its place being taken by one of the discharged groups. In order that the three groups in the supply circuit shall be as far as possible in an equal state of charge, it is essential that the changes should take place at frequent intervals, otherwise one group would become highly charged while the other three are being nearly exhausted. Therefore I have designed an apparatus by which each group is brought in succession into the charging circuit, charged for a short period—two minutes in actual practice—and then removed again into the supply circuit, in order that it may discharge itself. This apparatus, which works automatically, I call a distributor.

The operation of the distributor may be understood from this diagram*. You will see that the four groups of cells are lettered A, B, C and D.

These cycles of changes are essential to the efficient carrying out of this system, for we must guard against interrupting the main charging circuit, because of other work going on in the circuit at the same time in series with the battery under consideration. We must also be careful at no time to alter or fluctuate the pressure of the local batteries. We must also at no time have the charging main in contact with the local batteries, as this might cause a variation in their pressure, or, in an extended system, have a tendency to leaking through the local to earth with its attendant dangers. You will see, therefore, that by carrying out this cycle, we ensure all the requisite conditions.

In practice, this cycle of changes takes place at intervals of about every two minutes, the batteries, A, B, C and D, receiving their increments of charge, A for two minutes, B for two minutes, C the same, and D the same; so that in eight minutes each of the cells will have received two minutes' charge. The charge now proceeds in the reverse direction, from D to A, thus the cycle is

A, B, C, D, D, C, B, A, &c.

Although the process of describing in detail the changes which are shown in the diagrams, and which complete one cycle, have been somewhat lengthy, it must not be supposed that the actual change in the mechanical-electrical actions of the distributor which bring about the result are of any protracted period of time. If so, the value of the system would be neutralised. The actual time occupied is less than one second, so that in 24 hours

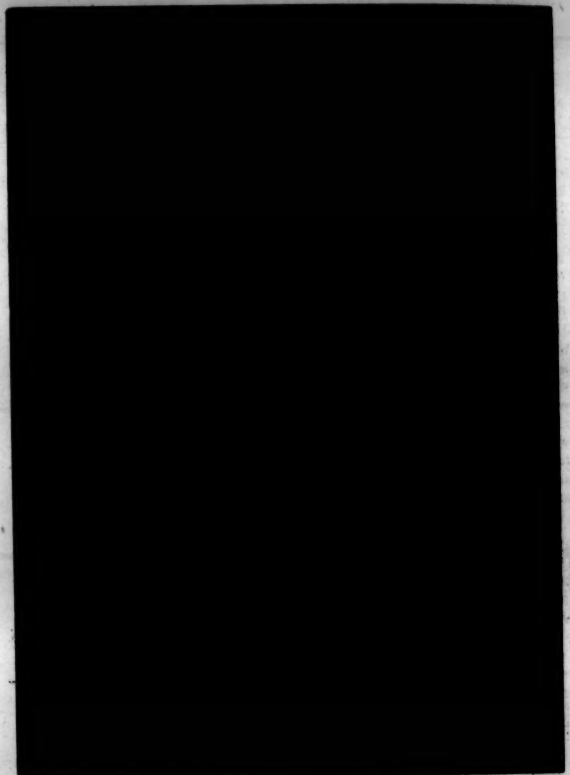


FIG. 1.

the distributor instrument is only actually under movement for 12 minutes. This practically consumes very little time, and prevents any appreciable wear of the moving parts. The time mechanism runs on jewelled bearings, and it has little wear.

Fig. 1 represents a well known curve, which has been drawn up by the Electrical Power Storage Company to show the rise of potential in charging with a 60 ampere current with the same size cells that we are using in our system. From this curve you will see that at the end of the discharge of a battery, i.e., after seven hours' discharge, its voltage has fallen to 1.9, whereas at its full charge the voltage is 2 volts; and when we take a discharged battery which has worked for 490 ampere hours, seven hours at 70 amperes, it is put in to be charged, and the result is that for the counter electromotive force required to charge that cell with a 60 ampere current, the potential would have to be 2.1. Now, as the charging is continued for a period of time, it gradually rises up to 2.2, that is after five hours; then there is a very sudden rise in the next three hours, bringing up the charging potential to 2.5. But in practice—I am speaking now of where batteries are charged either separately, that is, in the ordinary method, or charged and discharged at the same time, this is rather a serious drawback, because if you have that increase of voltage per cell, and there are 50 cells, there is a considerable difference of potential at the time of charging as compared with when the batteries are run while not being charged, and many devices and arrangements have had to be made, such as cutting out cells when charging, putting in resistance, or other things, in order to approximately balance the local potential. I find by the method of charging we follow

* This was published with Mr. Edmunds' British Association paper, appearing in the Review for September 14th, 1888.

that we are not troubled in that way. In the first place, in a cell receiving a 70 ampere current for a period of two minutes, the potential does not rise, then it goes into the charging circuit, and it will be observed that in 24 hours we only charge a group of cells, as a whole, with a 6 hours' current. On the other hand, we only want one-third of the charging potential in the main. This enables us to do a given amount of work with one-third of the plant, and one-third of the pressure at the charging station, compared with what would be required if we were doing the same amount of work by a direct system. This is very important. The cells are kept in much better condition by continually receiving fresh increments of charge, and having periods of rest from discharge. Also, the loss due to difference of potential between the charging and discharging current is minimised, it being found in practice that we can continue charging the cell to its maximum capacity with a mean voltage of 2.25, instead of 2.5 per cell, as is required where cells are charged continuously. This, on a large scale, is a considerable element of economy when there are a large number of cells in the charging main. Besides this, we find that an approximately constant potential on the local circuit enables us to run lamps at a higher efficiency without the risk of rupture due to sudden rise of pressure, and, so far as we can judge, the life of the batteries is considerably lengthened by this mode of intermittent charge and rest. We can keep up the voltage at 48 or 50 without varying, and can run lamps at a higher efficiency without fear of overstepping the mark, being sure that we shall not go above a certain mean, i.e., that on a circuit with lamps sent out by the makers as requiring 46 volts, we put them on a 48 volt circuit. This gives greater

E.P.S. cells are best charged. The voltage of the dynamo varies according to the work at any one time on the line, and the current is maintained constant at all times. A simple mode of ensuring these results has been obtained by using an ordinary series dynamo (fig. 2), whose field is excited from a separate source, by batteries for example, incidentally charged from the main, and the speed of the dynamo is varied in accordance with the variations of the work or external resistance of the circuit. I find that by proportioning the size of the engine to the dynamo it has to operate, we need only keep a constant pressure on our engine to ensure the regulation being entirely automatic. We have been able to dispense with electric regulators of all kinds in the station, for the dynamo practically regulates the speed of the engine, only going at a given speed in order to produce the requisite E.M.F. to supply the 70 ampere current through the whole of the work in circuit at any time. Should batteries be out of circuit, the result is that the resistance is lessened, upon which the volume of current is increased. This immediately acts like a break on the engine causing it to run at a less speed until it has accommodated its speed to the normal 70 amperes, provided that meanwhile the steam pressure in the cylinder has been kept constant. This can conveniently be done by means of an ordinary steam pressure regulator. Should, however, more work be included in the circuit, the result will be that the current will suddenly fall, freeing the breaking effect on the engine, causing it to respond, and run at a higher speed until such time as it has brought up the current to the normal of 70, of course demanding more steam which the stoker must look out for. In this way, it is only necessary, by means of a speed counter, to take the revolutions of the engine or

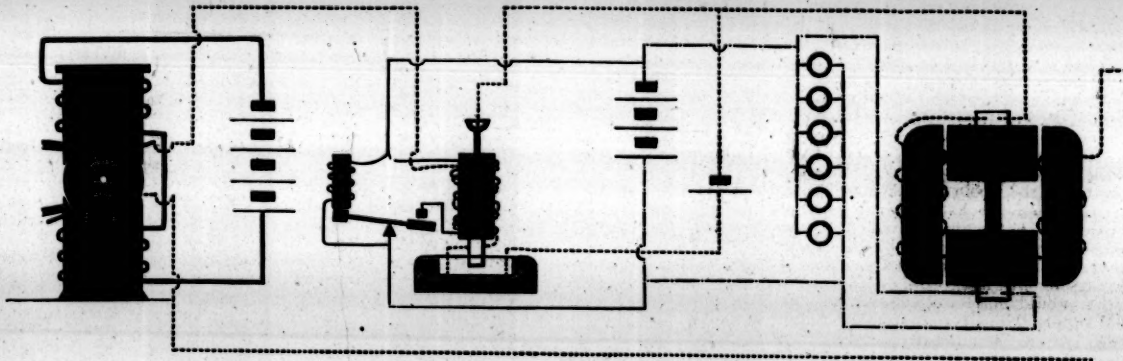


FIG. 2.

efficiency and we are not sacrificing the life of the lamp, because the perfectly steady current that we get compensates very much in prolonging the life of the lamp, which averages fully 1,000 hours, at the high efficiency of about 2½ watts per candle.

It is obvious that running a smaller station during the whole 24 hours is much more economical than running a large station only for a few hours during such time as the current is consumed. The current, being always constant in volume, enables a single main of one size to be used, preventing complications, and only requiring an increase of pressure as the work extends, which pressure, however, as has been pointed out, is only one-third of the sum of the pressures of the work done on the local circuits. For example, suppose batteries were used in 100 centres with an average of 50 volts each, giving the sum of 5,000 volts altogether, it would require at a central station to charge these altogether in series, a potential of over 6,250 volts, exclusive of the line; while by this mode of charging we can effect the same results with a charging potential not exceeding 2,000 volts, exclusive of the line. The safety ensured through this is of the highest importance, both in removing high pressures at the central station, and through differences of potential between the earth and the line at various points, considerably cheapening the cost of insulating the main conductors, and freeing the system from danger of leakage to earth, with its attendant dangers, enabling a lower grade of insulation to be used for interior wiring, and getting rid of that vexed question which all contractors are feeling with regard to complying with the requirements of the insurance offices. This is a considerable factor of economy in extended work, and is much more important than at first sight appears. Many people are objecting to the introduction of electric lighting more out of consideration to the first cost of installation, which is now enhanced by the many difficulties experienced in complying with the conditions of safety, where extremely high tension currents are used, than on account of the cost of the current as a matter of consumption. I think that is something to be appreciated. We find that from time to time we have had to increase the insulation of the conductors that are used, and as these very high tension currents are being introduced in London—and just now there are proposals for something very high indeed—I suppose greater care than ever will have to be taken. In this system I think we can effect all that can be done with the very high current tension transformer systems without having that at all, because the local circuits have only their local voltage and have nothing to do with the high potential at the central station used for charging them as a whole.

The current supplied from the dynamo at the central station is 70 amperes, this being the amount by which the large-sized

dynamo of the station at any time as being an exact index of the work going on at that time, and as the work increases when the speed of any one engine gets up to its mechanical limit of safety, two or more machines are then brought in series with the others and, acting in the manner already described, keep this constant current with its proper potential always on the main circuit. Having a time apparatus to effect the changes described in the battery, and a constant current in the main, it is only necessary to bring these two together, as the tension on the batteries is practically the same, in order to form a very efficient and simple meter, which, having only to deal with the current supplied in the charging, has not to differentiate, and take account of the varying amounts used in the discharge.

Of course it may be said that a system of this kind is essentially dependent on the mechanical details used for carrying the same into effect, and here actual practice has been of very great use to me. The Cadogan Electric Light Company, of Chelsea, having adopted this system, has enabled me to see actually what such shortcomings were. The apparatus I have here to-night is of the kind that has been in use there, and, like all first forms, has not performed as well in practice as it did with the care and attention it received in the laboratory.

The apparatus here consists of a powerful electro-magnet driving a set of cams, which operate four levers, each lever carrying a full set of combination of contacts for each of the groups of batteries in use at one time. This reciprocating lever arrangement, however, has shown a serious difficulty, for the levers have occasionally wedged themselves so tightly that the electro-magnet could not draw them out; or, on the other hand, have proved too slack, so that insufficient contact was made, and sparking and heating caused in the apparatus. All this, I am glad to say, has been got over by the substitution of a rotary for a reciprocal motion, and now I can show you an improved form of apparatus which is doing the work here this evening, which carries out all the requirements of this system in a much simpler manner. When any group of cells are sufficiently charged, so that they ought to be disconnected from the charging main, an arrangement called a voltage regulator is brought into use. This causes the batteries to be disconnected from the main, and to remain disconnected until such time as they are discharged sufficiently to reduce their E.M.F. to a lower level, when the apparatus automatically causes the battery to be again put into the charging main. It will be obvious that such a system as this is sufficiently elastic, by varying the number of cells, to give, practically, any potential that may be demanded, and can therefore comply with all kinds of requirements for lighting, arc or incandescence, or supplying current for other purposes. It is very desirable not to have too great

a variety of pressures, and, therefore, in houses where but a small amount is demanded, it is best to put down a plant of sufficient size to supply several together from one distributor, thus forming a small station, it being, however, always desirable to have the same as near as possible to the point of consumption, and much cheaper to carry our charging main there than to have the local discharge mains. It is convenient not to have such stations too large, or at too great a distance from their work. For suburban or scattered lighting this system is very useful, as only one main is required of, say, three-eighths of an inch cross-section, which can be conveniently carried overhead or underground.

The apparatus I now show you is the time mechanism arranged for giving the periods of change and of charge; and in conjunction with it is an arrangement which is a meter. We have seen that we have here a constant current, we also find that the movement of this magnet takes place at every two minutes; therefore it is only necessary, during such time that the charging current may be on, to put in a small solenoid, which we have here, carrying a worm and gear in connection with the counter; that counts practically the number of revolutions, and this making a revolution once every 16 minutes, we take 70 amperes $\times$ 16 minutes, and have an exact automatic measurement of the current going into a house. That does away with all the difficulty of differentiating the meter and of explaining, which is a very difficult thing to explain, where the current goes to that goes out of the batteries, and it removes a good deal of trouble, also, with regard to the contractors explaining about the loss in their batteries due to storage. By this method we simply charge for what goes in, and leave the consumer to take care of what goes out.

If our system be very much extended, then, by simply changing the direction of the current from the dynamo we can bring into operation another arrangement which I call a polarised switch. When the voltage in a battery is sufficiently high to cause an electro-magnet to tip up a lever, a small circuit is joined in, which is wound in a contrary direction to the solenoid of the main circuit—having but a fraction of an ampere flowing through it—and sparking is avoided, with the result that the local battery is cut out, but when the voltage in the local battery falls the lever falls, and the current passes on a smaller wire, which neutralises the current, and the whole acts like an automatic ball-cock to a water cistern. When the batteries are fully charged they cut themselves out of the main, and when they are wanting charge (not when they are fully charged, because I make a very great distinction there) they throw themselves into the main. Thus, supposing that we have a theatre or anything of that kind to light, where it would not be economical to put batteries down which would supply the maximum number of lights required, but where it would be easy to put batteries down sufficient for supplying an average number of lights, and which would prevent a theatre from being in the dark and causing panic—supposing that a greater demand on these lamps comes than the battery could supply, then we have an arrangement included in the circuit which I call a motor-generator. This is practically a motor and dynamo combined in one. When the charge from the batteries exceeds a certain point then the motor-generator is thrown into circuit and it is driven by the current from the main, the engine immediately speeds up to it, generates current in the local, reinforcing the batteries, keeping a steady current, and so, practically, it takes the place of a secondary generator in an alternating current system. That is, I think, a field which may be very fairly developed in this direction. Suppose, as I said before, that we have more houses on our circuit than the engines can charge, the polarised switches can be arranged so that we are enabled to supply a circuit of twice the length that the batteries would do normally, i.e., we could run two sets of houses on the same circuit, and by reversing the current in the circuit cause half the houses to come in at one period and the others to go out, and vice versa, and in that way we can extend very largely the operations from one station. In this paper I have not gone into the question of cost, but from the experience we have had think that such a system compares most favourably in this respect with any of the direct or alternating current methods, and I hope it will prove a means of supplying that great demand which all engineers feel is now upon us.

DISCUSSION.

The PRESIDENT: I think the discussion on the paper we have just heard is sure to be interesting, and perhaps it will be opened by some gentleman who is not a member of the Council.

Mr. A. RECKENSAUN: I can only congratulate Mr. Edmunds for the ingenious manner in which he has carried out this problem. I had the privilege of seeing the apparatus at work a few weeks ago at Hatton Garden, and I have been very much surprised at its absolutely accurate working. The only objection I found in the apparatus was that it appeared too delicate. When placed in a station where accumulators may be in close proximity to the apparatus there is the possibility of its metal becoming tarnished by the fumes which always exist. I anticipated, in regard to the movement, that there would be considerable sparking on account of the high charging current of 70 amperes, but I was very much surprised to find that the sparking, when the levers change position, is almost invisible. This is due to a resistance which is automatically shunted in during the operation. Mr. Edmunds has mentioned that the batteries are charged with a constant potential of 2.25 volts, whereas ordinarily the charging would have to be done with a potential of 2.5 volts. That, I think, is rather erroneous. According to the diagram the electromotive

force rises as the charging proceeds, from 2.1 to 2.5 or 2.6, but I believe that it would be difficult to maintain the charging electromotive force of 2.5 volts, because the counter electromotive force of the battery is practically that, and sometimes a little more, owing to the hydrogen gas which is always on the plates in a nearly fully charged cell, and which produces a fictitious electromotive force which is frequently above 2.25. I can only repeat that I felt very much interested in the paper, and congratulate Mr. Edmunds upon the admirable way in which he has carried out the system.

Mr. W. H. PREECE: I am sorry to say, sir, that I have kept no particular notes of the points that Mr. Edmunds has raised in this paper. A similar paper was read by him at the Bath meeting of the British Association, and he described there very fully his system. It was very well discussed, and I took that opportunity to express my admiration at the way in which the details had been carried out. There is something remarkably enticing in the system. Broadly, the principle has about it the merit, not only of novelty, but of success, and it also has been worked out in a manner that reflects the very highest credit on Mr. Edmunds. But we always find, in every new system, that if you attempt at first to attain completion and perfection you are sure to introduce complication and expense. The first thing in a novelty is to make it perfect. When you have made it perfect, and you find it expensive, the next thing is to try and cut off, break off, lop off the excrescences, and bring it down to within the range of practice. I think this plan of Mr. Edmunds, excellent as it is, is still in the experimental stage, where it is laden rather with excrescences that will have, in practice, to be cut off, and I think that he deserves a considerable amount of thanks from us for bringing a new thing like this before us in order that we may think it out for ourselves and probably assist him, as we all ought to do, in perfecting an advanced thing. Mr. Reckensaun has remarked upon one point that I must say I feared very greatly, and that was that the constant removal of a battery and its replacement in a circuit would produce rather intense sparks, because the current of 70 amperes is rather a severe one, and we always find that when we attempt to change the direction of a current in a circuit, either by a switch or any other contrivance, that invariably there is considerable sparking from leakage, but there are no sparks here, at least they are not perceptible, and I think that that is probably due to the fact that in the changes that are made by removing one cell or one battery out something is done that is not affected by that pest of all electro-magnetic apparatus, self-induction. There is nothing like self-induction in the charges made here, and the result is that the sparks are very considerably diminished. Another practical defect is the tendency that there is to make things too delicate: in carrying out changes of this kind you want something extremely substantial, very well made, and very well worked out; and I can see by the apparatus before me that Mr. Edmunds is gradually working up into a more practical stage than the first form of apparatus I saw in Hatton Garden was in. The next point that occurred to me, and about which I confess I should like to have heard a little further explanation from Mr. Edmunds, is the means by which, without governor, without compound winding, without any contrivance of any kind, he succeeds in maintaining a constant current in his circuit. He says it is so, I suppose we are bound to believe him; but there is something very peculiar about it, and something that requires a little further examination. As regards the automatic switches that are used the object is undoubtedly extremely valuable; we would like to have seen an apparatus of this kind used over and over again for different purposes, but I must say, as a practical man, that I dislike the introduction of any complicated apparatus to add to the complication of an already complicated apparatus, and I think the process itself should be simplified as much as possible, and though it is a very nice thing to use plant over and over again, it would be better without that complicated motor. With regard to those curves and to the counter-electromotive force, or rather to the voltage of batteries, there is, I cannot help thinking, a misconception existing about the behaviour of batteries when they are charged and when they are discharged. Those curves are evidently curves that have been drawn from actual experiments, the form of the curves showing the rise of voltage, hour by hour, as the battery is charged, is a curve that is perfectly familiar to me, and is one that I have reproduced over and over again, but there is another curve wanting that is of more consequence than even the curve of voltage, and that is the curve of current. If you take a record of the variation of voltage during the time a battery is charging, and also of the variation of current, you will find that while the voltage is increasing the current is diminishing, and the result is that the voltage per unit of time at any particular interval is very nearly the same. Now, when you discharge, you discharge a battery at a very much lower voltage, and the general impression, I am bound to say, among the great majority in this room, is that when you discharge a battery at a very much lower voltage than that battery takes when it is charged, is that you get a very great loss of energy. Well, you do not, as a matter of fact a secondary battery has one remarkable point connected with it that has raised and received very little attention, and has not received the attention it deserves. It is this, that a battery is a kind of automatic governor, that the internal resistance of a battery that controls the external work done by the battery varies with the current that goes through it, so that if you discharge a battery at 1 ampere you get one internal resistance; if you discharge it at 10 amperes you get very nearly one-tenth of the internal resistance. In fact, the internal resist-

ance varies with the current that is taken out of it, and the result is that unquestionably, I think, the voltage of discharge is very much lower than the voltage of charge. The number of watts taken out at a given time are practically the same, and the result is that, if 300 ampere-hours are put into a battery, when it is discharged with a small current, very nearly the whole of the energy can be taken out of it. I have succeeded in extracting from a battery 98 per cent. of the energy put in, and that is really due to the fact that the internal resistance varies with the amount of discharge current. There are several practical suggestions that Mr. Edmunds has raised. One appeared to me to be rather serious. I did not quite catch what he said, but the serious point is really the difficulties that are placed, not only in the way of contractors in carrying out work, but in the way of consulting engineers who have to carry out that work. We find that restrictions are increasing day by day in the character and quality of wire—for instance, that seemed to be quite unjustifiable. I have only recently heard that somebody has planted his foot down upon pure India-rubber. Well, now, it is rather a curious thing that we in the Post Office who have had some experience in the use of insulating materials of different kinds will specify pure India-rubber only for our aerial cables that have to carry currents, whereas we are now told that pure India-rubber is entirely tabooed, it must not be used, and that nothing but vulcanised India-rubber must be employed. That may be all very right; it may be very true and very just, but at the same time we practical men who have had 30 years' or more experience of pure India-rubber would like to know why that substance that we have used so much, now, in the year 1888, turns out to be bad. There is one other question, and one of rather serious consequence. Last year when I spoke here I referred to the merits of a new class of wire that was being introduced as a mode of maintaining the insulation by coating the insulating compound with lead. I referred more particularly to the remarkable insulating properties that the refuse of petroleum, with a combination of resin and resin oil possessed, and we know that it is only possible to maintain the perfection of this by a lead coating. We have had some experience of lead covering, but I must own that I should like to find in some of those attempts to introduce batteries and those attempts to use high tension currents, especially converters and transformers, some practical men who have really tested the merits of lead-covered wire and found out if it possesses defects or not.

Mr. GIBBERT KAPP: Mr. Preece spoke about this system of working a steam engine without a governor, as if it were something doubtful or dangerous. I may say that it was done some years ago by Mr. Bernstein, and there is really nothing at all doubtful about it, it is a perfectly easily understood thing. There is a delightful simplicity about the rule, for each pound of steam one ampere, the pressure against the piston being constant, the torque on the armature is constant if the current is constant, the field being also constant, because it is always excited from the same number of cells, so that on this account the engine power it requires will give no trouble at all. But I think it will give trouble in another way, viz., in the coal bill. Engines are very patient things, they can be worked at different degrees of expansion and at different speeds, and they will consume the same amount of steam per horse-power. But there is a limit to their patience, and if an engine is worked just crawling round, the weight of water per horse-power will be found to enormously increase. The reason for this is that the steam has time to condense in the cylinder. The great advantage of high-speed engines, such as the Willans, is that the steam has no time to condense, it is in and out in a moment, and has done its work in the cylinder; though the cylinder may be of a metal which conducts heat very quickly, yet it will not have time to give away many heat units, and the engine is almost as good as if it were made of a non-conducting material, provided the engine runs fast enough. If it runs slowly it is a comfortable thing for the man in charge, I admit, but it is not good for the man who has to pay the coal bill. It is, I think, a questionable advantage to work in this manner, though it is perfectly possible to do so on scientific grounds. While on this subject I should like to ask a question. I understand Mr. Edmunds to say that the generating plant, by which he means the boiler, engine and dynamo, can be a third of what would be required in a battery system arranged on what is generally known as the Colchester plan, where there are two batteries, one being charged while the other is working the local circuit, one being taken out and the other put in the charging circuit. On first looking at it that, I think, seems right, but I am not sure in my own mind that it is so. One of the conditions of working the batteries is that they should receive only small increments of charge, for two minutes, and during the next six minutes' discharge themselves in order that they may not become overcharged, and that the counter electromotive force of the battery may not rise up to the high point of the curve. If that is so, and the batteries are not to have an accumulative charge, then I cannot see how anything can be saved in the strength of the generating plant, which must be exactly as powerful as if it were used for direct lighting. If, on the other hand, an accumulation of the charge is allowed, the argument falls to the ground that the batteries are used in a better way in this case, and, in fact, the circumstance that Mr. Edmunds puts a regulating magnet in which can only come into play upon a rise in the wire, shows that he anticipates that the batteries will accumulate charge, that they will give a greater E.M.F. than 2.2 volts, and that they will cut themselves out. I should like to ask him whether this magnet can be so delicately adjusted that it will come into play at a pressure of, say, 2.25 volts, or just at the knee

of the curve, before there is a great amount of electromotive force. If that is so, I can quite understand that the lamps can be worked at a higher voltage than that at which they are labelled, and that the light will be exceedingly steady. But then we come to the other horn of the dilemma, that we cannot charge up the batteries during the daytime and draw on the charge during the night, but we live from hand to mouth so to speak; as much as the engine puts out the consumer takes in the evening. I would draw the attention of the meeting to the very beautiful magnet which has been adopted by Mr. Edmunds. I am under the impression that I have seen it before, but perhaps it is original, anyhow it has a feature that is well worth our attention. In this magnet he has got over what Mr. Preece calls the pest of dynamo-electric machinery, self-induction. This magnet has a circuit round it which is always closed and therefore in that circuit there can be no sparking. There is also another circuit of a shunt wire of high resistance which has a demagnetising effect. When the current flows through the shunt wire there is no magnetism in the iron core and the shunt acts as if it were inert resistance, there is no sparking. When the shunt circuit is broken there is a good deal of magnetism in the core, but on closing it again there is no spark, so that there is really the very beautiful thing of an electromagnetic instrument which can be put in and out again, which will give all the advantages of a magnet without the disadvantages of self-induction. I am rather sorry that Mr. Edmunds has put the motor generator into the diagram. The great object of his system, I think, is to do away with motor generators. We do not want moving machinery in houses, or even in a theatre, if it can be helped, and the arguments that might be used in favour of this motor generator in one particular spot may be used all over the line, and then batteries would disappear and motor generators only be used. I hope he will not put such a generator on, because one very great advantage of his system is that he has really perfect insulation. One of the most important parts of the system is that the local circuit is as insulated from the high tension circuit as if they were in two different places, and with motor generators that high insulation cannot be attained. Mr. Edmunds has told us that there is a thin insulating partition between the two circuits; it is bad enough in a transformer, I admit, but when you come to a motor generator with an armature subject to high mechanical strains, it is better to be left alone. I would much rather not use a motor generator at all on a circuit which may carry 2,000 volts.

Mr. W. P. GRANVILLE: I should like to ask how many fresh contacts this system would introduce into each sub-section, and how many houses of ordinary size would be conveniently worked on each sub-section. These questions may practically affect the system.

Mr. KENT: I should like to ask what is the particular advantage of using a magnet as the resistance in shunt with the cell, in order to maintain the current throughout the charging circuit. I do not know why resistance should not be used which would have less self-induction than that.

Mr. H. EDMUNDS: You have misunderstood me. It is as a shunt to the resistance.

Mr. MADGEN: I do not wish to revive the war between the A.T. and B.T. systems, as the advocates of each appear to have buried the hatchet, and are determined to work their systems, leaving time to show which is the best. But we were rather given to imply, in the discussion which took place on Mr. Crompton and Mr. Kapp's papers, that the B.T. system would not be subject to loss by conversion, but that seems to have gone down altogether; the house circuits are not to be in contact with the batteries at the same time that the primary or high tension main is. Mr. Edmunds mentioned that in his system the insulation of the wires could be lower than with an alternating current system, and that people objected to the high price; but I do not suppose that the extra price for a well-insulated service would make very much difference in that respect.

Mr. D. C. BATE: It seems that not only will this system of secondary battery distribution not reduce the cost, but that it is liable to increase the cost, not only over transformer systems, but also over battery systems. If these batteries are discharged at more than one-third of the maximum charging current there will not only be no accumulation, but there will be simply a loss; and taking 70 amperes as being put in, the battery must not discharge more than about 20 amperes, or else there will be a considerable reduction instead of an increase per cell. The cells would be larger than in the Colchester system, where they are allowed to discharge in full and are then replaced by others of equal capacity. Where there is a charge of 12 hours and a discharge of 12 hours, as Mr. Preece has said, 98 per cent. of efficiency can be obtained at a low rate, whereas here a charge of 6 hours only is obtained out of the 24. With the solenoid used to cut out half the house, roughly, by the current in the dynamo being reversed, Mr. Edmunds appears to anticipate running the station for 24 hours, and, if so, does it not seem that there would be no necessity for reversing the current or doing anything of that sort, because as each battery is charged the solenoid will cut it out, and therefore he would be able to put on the same number of batteries as if he charged for 12 hours on one set and 12 hours on another. I must admit that I still do not understand the engine running without a governor, and I hope Mr. Edmunds will give some of us who do not understand it further information on the point.

Mr. A. P. THORNTON: I hope that Mr. Edmunds in his reply will favour the meeting with a further explanation of his time apparatus, by which the circuit is cut out every two minutes. I can corroborate Mr. Kapp's remark about the constant current: I

took the trouble some time ago to carefully make a constant current regulator, but I found that it was very much better to take the throw off the governor and let the engine go ahead with an open throttle valve, but whether that would answer on a large scale I cannot say. The system is extremely ingenious, and one would like to look at the figures more carefully, because Mr. Edmunds said that one-half the machinery will do twice the work, but it looks as if a wonderfully high coal bill would be the result. Great stress has been laid upon the insulation, and upon the main being quite separate from the batteries and lamps, but I understand, as our friends across the water would say, that 6,000 volts go fooling around somewhere inside this beautiful arrangement. Mr. Edmunds will perhaps tell us what is the distance or thickness of the insulation that the main, which I suppose gets inside this box, is away from the other contacts which carry the current away. I do not mean to be flippant about these matters, because any of us who are at all familiar with the ingenious inventions of this nature which Mr. Edmunds has from time to time worked out, cannot but admire the extreme ingenuity which he has brought to bear upon them.

Prof. G. FORBES: I am glad to have this opportunity of saying that I think we are all agreed that the subject that has been introduced to us is one which is now absorbing more attention than ever it has done, and one to which we look for such fertile inventors as Mr. Edmunds to bring us many new materials in the future. Having now become fairly satisfied with the apparatus of one system of distribution, we naturally look forward to the time when we shall be able to distribute on an alternative plan. It seems but a very short time since the question of distribution was being discussed, and appeared quite hopeless, and all of us will feel a great relief when the time does arrive that a system of distribution, Mr. Edmunds's or any other, which is combined with storage batteries, gives us a more efficient and a more economical method than that which is at our disposal at present. The chief difference in the general principle, which I notice between Mr. Edmunds's system and others which have been proposed for using secondary batteries is, that by his ingenious plan of charging and discharging cells alternately, at very short intervals of time, the cutting out of cells is altogether avoided. In every other system of using accumulators which I am acquainted with that is the trouble which has to be met, that when fully-charged cells are first put into a circuit they have a higher voltage than they have after a short time, and that a certain proportion, one or two cells, have to be cut out, and the complicated devices which have been attempted to be used to accomplish this end have, so far as I have seen them at present, not been successful. There are some, I believe, which have lately been brought out which I have not yet investigated, but Mr. Edmunds's system is one which is free from that defect. There are a great many points which it is almost impossible to discuss without one having considered the paper far more fully in detail than one can by simply hearing it read. But several speakers have raised a question which I should also like some information about—that is, as to the advantage of using the cell, both in charging and discharging, at about half-charge, and never over that. It seems to me that the batteries are never used at more than one-half of their charge, and also that we are in this system depending upon only half the charge which they are capable of using. I noticed that Mr. Edmunds gave an expression of dissent when a similar remark was made by another speaker, but I fail to see the way out of the difficulty, and I should be very glad to hear his answer to that. I was extremely pleased to hear Mr. Edmunds make himself responsible for the statement that he has lamps which are working with 3½ watts per candle-power, and whose life is considerably over 1,000 hours. That was news to me, and I should be glad to know something more about the lamps. When Mr. Edmunds described his system of self-regulation to me I did not know of Mr. Bernstein's experiment, and what seemed to me at the moment was that the system is exactly the converse of the result in motor work, which, to the best of my recollection, was first announced by Marcel Deprez. With a series motor, or a motor excited by a constant current, the load may be varied as much as you please, and the volts will go up, but the current will remain perfectly constant; that is exactly the converse of what is applied to a dynamo—one is the case of a motor working against pressure, the other is the case of a dynamo being driven by the constant pressure of a steam engine. I should like Mr. Edmunds to give a little detail information about his method of automatically introducing a second and third engine to assist in the work. It seemed to me that he passed over that point a little lightly, and it does not appear quite such a simple affair as he would lead us to believe. The weakest point in the necessary apparatus of the system seemed to me to be the make-and-break of which Mr. Kapp approved so much. In an apparatus which is to be used day and night from month to month, the putting in of anything in a consumer's house in the shape of a make-and-break is, I think, to be at once condemned. I agree with the remarks of Mr. Kapp about the motor-generator, but I look upon that as being a subsidiary thing, and not as essential to the main features of the system. As Mr. Preece said, too, I think it is quite right that every detail should be suggested, it is easy to lop them off as time shows that they are not of any use. The first general feeling that one has about this system is that there is a little too much complexity in the apparatus which is to be put in every house; and it would have been well, I think, if Mr. Edmunds could have given some information of the approximate cost of the apparatus which is to be added to the ordinary apparatus with which a house is installed. It is impossible to give any offhand opinion as to the relative cost of this system and others,

the cost of installation and the cost of working; it is not the duty of those who are discussing the paper to give detail figures on those points. It would be well if we had two approximate estimates, even though they were merely of a theoretical nature, to give us some basis on which to judge of the relative cost. But the cost of the plant and its working will have to be worked out afterwards, and if then the complexity of the apparatus is not very serious, I think the system in its general features is one of very great beauty indeed. As regards the motor generator, I would ask Mr. Edmunds if he does not think that having those machines on such very high potential circuits, it would be extremely difficult to get perfect insulation for them? I fancy it would be. It was not my intention to be critical about the points of this paper, I am extremely delighted with the general scheme which has been put before us, and I am sure that every one here will look forward with great interest to the development of Mr. Edmunds's system to see how it works in commercial practice.

Mr. H. EDMUNDS postponed his reply till the next meeting. The meeting then adjourned.

CORRESPONDENCE.

Galvanometer Discharge Deflections.

Referring to the correspondence column, page 532, of the ELECTRICAL REVIEW of the 9th inst., the following notes on the subject of "Galvanometer discharge deflections" may, perhaps, not be found without interest.

The discharge test with cable to earth at the other end has been in use on the Great Northern Telegraph Company's cables as part of the regular monthly tests for several years. This special discharge test has been introduced in order to give the electricians some practice in the taking of the discharge test in case of breaks with partly sealed up ends.

For the purpose of this test the formula $\Psi = \sqrt{\theta(\theta - 2\phi)}$ from Hockin's paper (*Journal Society Telegraph-Engineers and Electricians*, vol. ix., p. 220) has been used, owing to the disturbing influence of the "current from the cable," only with the modification that u is substituted for 2ϕ .

u = the instantaneous deflection of the "current from the cable" after the discharge current has been let off without passing the galvanometer.

By this modification the formula appear to be rendered more suitable to the different types of galvanometers, for if

1. The current from the cable = 0, then $\Psi = \theta$.

2. $\Psi = 0$, then $\theta = u$.

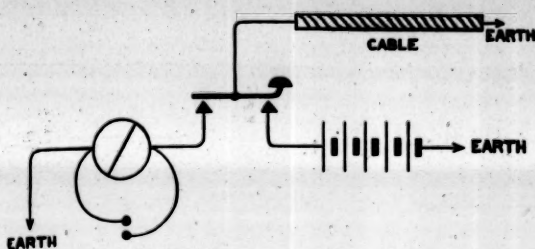
As in the case of the ordinary marine galvanometer the proportion between 2ϕ and u is about 2 to 1·8 the Hockin formula is unavailable when the deflection owing to the discharge is very small compared with the deflection due to the "current from the cable."

The following examples showing the discharge test from month to month with a cable to earth at the other end and illustrate the application of the formula $\Psi = \sqrt{\theta(\theta - u)}$.

θ	u	Ψ calculated to	Discharge when insulated.	Copper resistance.	Dielectric resistance.
		Microfarads.	Microfarads.		
455	175	31·24	105·6	1795 ^m	51,000 ^m
490	265	33·15	105·5	1795	83,000
545	340	30·62	105·7	1800	64,000
550	170	31·22	106	1802	73,000
505	235	32·5	105·8	1807	59,000
530	380	34·28	105·6	1811	64,000
364	230	30·88	103·5	1811	41,000
440	180	35·41	112·4	1804	53,000
530	115	34·19	108·9	1793	38,000
410	135	34·66	109·5	1783	38,000
535	340	33·25	114·4	1804	45,000
480	240	34·57	111·2	1799	48,000
580	200	34·83	112·8	1800	47,000
530	175	31·96	108·2	1796	42,000
545	345	33·59	115·4	1805	43,000

These examples show that the results obtained are very near alike, and, in fact, within a third part of the discharge when the other end is insulated.

The discharge test is taken with the copper current to the cable, and the manipulation is as follows:—



1. The cable is charged for some seconds and then discharged through the open galvanometer; the deflection θ is noted down. 2. The cable is again charged and then discharged outside the galvanometer (the key is pressed down). Immediately thereafter the galvanometer is opened (the key is lifted), and the deflection α is noted down.

In case of a break with partly sealed up end, the copper current is first put on for some time in order to seal up the end as much as possible, and the discharge test is then made as above. The discharge calculated in microfarads divided by the capacity per knot then gives an absolute minimum distance to the break (the lowest possible copper resistance gives an absolute maximum distance to the break).

The above demonstrates the usefulness of introducing the pointed out formula when testing to breaks with partly sealed up ends.

In case of a quickly polarising and depolarising ends at the break, the formula in Hockin's paper (*Journal Society Telegraph-Engineers and Electricians*, vol. ix., page 219),

$$\phi = \frac{\theta_1 \cdot \theta_2 - \theta_2^2}{\theta_1 + \theta_2 - 2\theta_2}$$

can be adopted. α is then found from the instantaneous deflection, and the permanent deflection of an arbitrary current through the galvanometer in use.

E. B. Petersen,

Electrician to the G. N. Telegraph Co.

Copenhagen,

November 19th, 1888.

Gilbert's "Shackle Ball."

It will make experienced railway men smile when the junction terminal pole illustrated in last week's REVIEW meets their gaze. After the rebuke administered by Mr. MacDonald, it was thought that the indefatigable superintendent was knocked into the proverbial "cocked hat," but northern vigour it seems is not to be daunted by hard blows. Everyone knows that the Bright shackle is a poor insulating medium—although the best terminator yet devised—and has been rapidly replaced by the terminal insulator. Why on earth Mr. Gilbert could not use the latter and obviate the necessity of an auxiliary in the shape of "shackle balls" is only patent to himself.

We now obtain a glimpse of the superior telegraph construction foreshadowed in previous letters from this improver of systems, and what a rude awakening. Ye shades of MacDonald! where art thou? The "shackle balls," which are apparently the same as commonly used by the American electric light companies, are surely not a "patent."

If such a pole had been erected by less enlightened engineers in this part of the country, they would have obtained for the purpose a nice square pole, have double armed the same, have fitted boxing between the ends of the arms the exact width of the pole, notching out for the arm, so that when erected it appeared to form part and parcel of the pole itself. They would also

have carefully fitted leading in cups under each arm, have terminated the wires on terminal insulators, have properly stayed the pole (which in the illustration appears to be ignored) using proper eye bolts and machine stranded stay wire, and finally fitting a finial to the pole. So much for workmanship as regards an improvement in the insulation. I don't think "shackle balls" will be the medium adopted here. Mr. MacDonald advised your correspondent to come south and have a turn round. I should advise Mr. MacDonald to take a trip to the "Hislands."

Alfred Constance.

Wheatstone Instruments out West.

I take the liberty of writing to you from this distant portion of the globe, giving your readers an idea of the immense volume of press matter telegraphically transmitted, and the method used for the same during the late elections, which has been one of great excitement. You have probably heard of the overland circuit operated by the Wheatstone automatic duplex system between Chicago, Illinois, and San Francisco, California. This circuit is the longest circuit in the United States that is permanent and in daily use. The value of the system has become apparent by the immense volume of matter handled, which aggregated nearly 150,000 words daily during the excitement. The repeaters of this circuit are located at Omaha, Nebraska, Cheyenne, Wyoming, Ogden, Utah, and Reno, Nevada, each of which has a special attendant. Nearly all the press matter destined for the Pacific coast was handled on this circuit, each of the repeaters taking a drop copy for their respective districts. Another important Wheatstone circuit is operated between New York and Chicago with one set of repeaters at Buffalo, New York. This circuit being out of my hearing, as it were, I will not attempt to go into details.

The system, as a whole, is giving much satisfaction to the Western Union Telegraph Company, for the obvious reason that there is economy in wires, and that the help employed is somewhat cheaper than is employed on other systems. Mr. S. P. Freir, late of Sheffield, England, is electrician for the system and manager of the repair department.

Louis Casper.

Cheyenne Wyo., November 8th, 1888.

The Insulation Resistance of Industrial Electrical Installations.

In the ELECTRICAL REVIEW of last week you print a translation of M. Picou's communication to the Société Internationale des Electriciens on this important subject, wherein he correctly states that it has not been hitherto well discussed and defined. I have written a short paper upon the subject for the Society of Telegraph-Engineers and Electricians which I hope they may read and discuss at an early meeting. I shall therefore not anticipate the remarks made in my paper further than to state that more than four years ago I devised a rule very similar to that now proposed by M. Picou, which rule will be found in the last three editions of Munro and Jamieson's "Pocket Book of Electrical Rules and Tables" (see 5th edition, p. 179), and which I have applied to more than 20 installations. M. Picou's formula, as stated at p. 584 of the ELECTRICAL REVIEW, reads:—

$$x = k \frac{E}{I}$$

Where x = the total insulation resistance of the circuits in ohms.

k = a constant (500) found by experiment upon short lengths of wire used for installations.

E = E.M.F. of dynamo.

I = total current passed through circuits when in full working condition.

My rule put into formula shape is

$$I_t = k \frac{E}{N_L}$$

Where I_t = the total insulation resistance of the circuits.

k = a constant ($\cdot 1 \Omega = \frac{1}{10}$ th megohm = 100,000 ohms) found by actual tests from several well erected installations.

E = E.M.F. of dynamo.

N_L = number of lamps (16 C.P.) on circuits when in full working order.

It will therefore be seen that the differences between these two rules lie simply in the values given to the constant, k , and the substitution in the former (Picon's) of the maximum current for the number of lamps of normal candle-power in the latter (Jamieson's). Otherwise the leading principle is the same, viz., that the insulation resistance of an electric lighting circuit should be taken as directly proportional to the electromotive force and inversely to total current or total number of lamps in the circuit.

I believe that M. Picon's constant 500 is too low to ensure that good work has been carried out and will be maintained. Under conditions of say 100 volts at dynamo and $\cdot 5$ ampere per lamp, it demands only $\frac{1}{10}$ th of the total insulation resistance that my rule requires. I now find no difficulty in getting contractors to accept and work up to my rule when they can get a fair price for their work, and thus use good material and workmanship throughout.

It was only last week that I was called in to test the insulation resistance, &c., of the installation lately fitted by Messrs. McWhirter, Ferguson & Co., electrical engineers, Govan, into the Allan Glen's Technical School, Glasgow, where there are 100 lamps of 16 C.P. with 100 volts E.M.F. and a total current of 64 amperes or $\cdot 64$ ampere per lamp. I found immediately after a three-and-half hours' run at full-load a total insulation resistance (against dead earth of gas pipes) of 200,000 ohms including all leads throughout the lamp circuits, the main switch, intermediate and lamp switches, cut-outs and lamps; or just double the insulation resistance required by my rule. For

$$\begin{aligned} I_t &= k \frac{E}{N_L} \\ &= 100,000 \times \frac{100 \text{ v}}{100 \text{ L}} \\ &= 100,000 \times \cdot 1 \Omega \end{aligned}$$

or 100,000 ohms is all that the rule requires for such a case, whereas M. Picon's rule would be satisfied with

$$\begin{aligned} x &= k \frac{E}{I} \\ &= 500 \frac{100 \text{ v}}{64 \text{ a}} \\ &= 781 \text{ ohms} \end{aligned}$$

total insulation resistance. Roughly, from $C = \frac{E}{R}$

or from exact calculations of all the derived circuits, this insulation resistance would shunt to earth about $\frac{1}{10}$ th of the total current passing through the lamp circuits. Now the Society of Telegraph Engineers in their last pamphlet on the "Prevention of Fire Risks" demand that the leakage to earth shall not exceed $\frac{1}{1000}$ th of the total current intended for the supply of the lamps. Mr. Heaphy requests in the "Phoenix Rules" a minimum total insulation resistance of 10,000 ohms irrespective of the size or extent of the installation, whilst the Westminster Fire Office demand 150,000,000 ohms per mile!!! Truly this subject requires to be discussed and defined.

M. Picon proposes exactly similar tests to those devised some years ago by Dr. John Hopkinson for faults when the circuits are at work (compare M. Picon's remarks as reported at centre of first column ELECTRICAL REVIEW of last week, p. 585, with

details and figs. p. 215 Munro and Jamieson's Pocket book, p. 215).

Andrew Jamieson.
Prof. of Engineering.

The Glasgow and West of Scotland
Technical College.

November 24th, 1888.

[What a pity it is that all electricians cannot agree to use the same letters for the same common and now universally accepted terms, viz., current, electromotive force and resistance, &c. In the above we have Mr. Picon's letter, I , for current, whilst Prof. Jamieson and most electricians in this country use the letter, C , and so on throughout the whole vocabulary of electrical terms.—EDS. ELEC. REV.]

Capacity Tests.

In making capacity tests with "Varley's slides" I am unable to get correct results, and find they differ with condensers of different capacities. I am afraid I have made some mistake in the connections. The handbooks on testing seem to be very vague on this subject. If any of your readers would kindly give me some information on these tests and their experience of them I should be greatly obliged.

Perplexed.

[Our correspondent's letter, too, is rather vague, and does not state how he has made the connections, otherwise no doubt there would be little difficulty in putting him right. Perhaps some of our readers who have had practical experience of these tests may be able to say something on the matter.—EDS. ELEC. REV.]

Sad Death of M. Gaulard.

I have the painful duty to inform you of the death of Lucien Gaulard, electrical engineer, who died yesterday at St. Anne madhouse, broken-hearted, a victim of science and of his own great genius.

I enclose a letter, in French, which I have this day sent to the electrical papers here, and I thought that perhaps you would not mind associating yourself and your paper in the expression of universal regret that this sad death must evince in all generous hearts and all lovers of science.

Whatever can be said, Lucien Gaulard will go to posterity as the first one (to say the least) who has invented the practical way of transmitting electrical currents to a great distance. Look to every part of the world, the great impetus, the immense projects of central stations of the greatest magnitude! Who is the primary cause? Lucien Gaulard!

I am sure that the greater portion of your numerous readers, and the great mass of the English nation, always ready to be fair, and honour real worth, from wherever it comes and wherever it goes, will associate themselves readily and spontaneously, and join with us French electricians in the great loss we have sustained by the death of Lucien Gaulard, and will give his widow this supreme satisfaction in the midst of her grief: that they honour the memory and genius of the departed and unrewarded husband.

E. H. Cadot.

November 27th, 1888.

Charges for Electric Supply.

We notice in the issue of your valuable paper on the 24th inst., that you refer to our scale of charges for electricity in Kensington, and we think it only right to advise you that we are indebted to Mr. Holmes, of the Liverpool Electric Light Company, for particulars of the scale which we have adopted, and we understand from this gentleman that it has been in use with great success at Liverpool for some few years past.

The House-to-House Electric Light Supply
Company Limited,
H. ST. JOHN WINKWORTH, C.C., Secretary.

November 26th, 1888.